Combining a System-Centred and a User-Centred Approach in the Development of Public Self-Service Applications

Billestrup, Jane

DOI (link to publication from Publisher):
10.5278/vbn.phd.tech.00033

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

COMBINING A SYSTEM-CENTRED AND A USER-CENTRED APPROACH IN THE DEVELOPMENT OF PUBLIC SELF-SERVICE APPLICATIONS

BY
JANE BILLESTRUP

DISSERTATION SUBMITTED 2018

AALBORG UNIVERSITY
DENMARK

Combining a System-Centred and a User-Centred Approach in the Development of Public Self-Service Applications

Ph.D. Thesis

Jane Billestrup

Thesis submitted January, 2018

Dissertation submitted: January, 2018

PhD supervisor: Prof. Jan Stage
Aalborg University

PhD committee: Professor Peter Axel Nielsen (chairman)
Aalborg University

Reader Lai-Chong Law
University of Leicester

Professor Ebba Þóra Hvannberg
University of Iceland

PhD Series: Technical Faculty of IT and Design, Aalborg University

Department: Department of Computer Science

ISSN (online): 2446-1628
ISBN (online): 978-87-7210-135-4

Published by:
Aalborg University Press
Langagervej 2
DK – 9220 Aalborg Ø
Phone: +45 99407140
aauf@forlag.aau.dk
forlag.aau.dk

Printed in Denmark by Rosendahls, 2018

Abstract

This thesis examines the development process and quality of public self-service applications in Denmark. Since 2011, the countries in the European Union have implemented joint strategies for digitalising public services, such as communication between citizens and the government or municipalities, with the expectation that business would be enhanced and economies improved.

In Denmark, the focus has been on implementing e-government and mandatory public self-service applications to be used by all citizens. However, the digitalisation of public self-service applications in Denmark has been criticised by the public, the media, and government agencies for lack of usability.

This thesis consists of six contributions used to answer a general research question along with two research questions on the current practices in the development process and the overall approach taken by the companies developing the public self-service applications in Denmark.

The general research question was: "To what extent can companies developing public self-service applications benefit from combining a system-centred and a user-centred approach, and how does that affect the quality of the systems?"

Single and multi-case studies were conducted regarding the development process of public self-service applications. These case studies included the use of semi-structured interviews, a questionnaire survey, and content analysis. Usability evaluations were conducted of the released public self-service applications to assess their quality.

This thesis provides the following three sets of conclusions. First, companies developing public self-service applications are primarily using a system-centred development approach focusing on technical features and aspects. Citizens are perceived as lacking the motivation to use the public self-service applications. From the citizens' perspective, the quality of the public self-service applications is poor, which is in alignment with citizens not being made a priority and not being involved in the design and development process.

Second, companies lack knowledge about user-centred design techniques

such as Personas. Caseworkers were involved in the design and development process to some extent, which resulted in public self-service applications devoted to simplifying the work processes for the caseworkers and easing their workload. It was found that the interviewees from the companies developing the public self-service applications wanted to employ a more user-centred approach, but this approach is perceived as being too expensive. However, if usability evaluations of the developed public self-service applications were mandatory, the interviewees perceive the companies would have to employ a more user-centred approach.

Third, part of the motivation for the digitalisation of public self-service applications was to reduce administrative costs. A report from 2016 produced by the National Audit Office in Denmark showed that the digitalisation of mail sent from government agencies to citizens and companies has only produced 20% of the predicted savings. These savings came directly from not paying postage. The expected reduction in payroll costs has not been achieved. Such results have led to the municipalities developing strategies for including citizens in future digitalisation processes. These new strategies focused on including citizens in the design and development process are in alignment with the conclusions drawn in this thesis.

This thesis has identified several obstacles to combining the currently employed system-centred approach with a more user-centred approach. If these obstacles can be overcome, this combination can be beneficial. Involving caseworkers has been found to lead to an increased focus on adding value for them by developing public self-service applications focusing on simplifying their tasks and work processes. Combining the system-centred and user-centred approach would maintain the focus on developing functional, technical applications that would provide increased value and usability for both caseworkers and citizens.

Dansk Resumé

I denne afhandling undersøges udviklingsprocessen og kvaliteten af offentlige selvbetjeningsløsninger i Danmark. Siden 2011 er der i EU blevet implementeret en fælles strategi for digitalisering af offentlige selvbetjeningsløsninger, eksempelvis kommunikation mellem borgere og myndigheder eller kommuner. Forventningen har været at dette ville forøge væksten i virksomheder og forbedre økonomien.

I Danmark har fokuseret været på at implementere digitale selvbetjeningsløsninger som er obligatoriske for alle borgere at anvende. Men digitaliseringen af disse danske selvbetjeningsløsninger har fået kritik fra både borgergrupper, i medier og af offentlige styrelser på grund af manglende brugervenlighed.

Denne afhandling indeholder seks artikler som benyttes til at besvare et overordnet forskningsspørgsmål og to underspørgsmål om praksisser anvendt af virksomhederne i udviklingsprocessen samt deres tilgang til udviklingen af offentlige digitale selvbetjeningsløsninger i Danmark.

Det overordnede forskningsspørgsmål havde følgende ordlyd: "I hvilket omfang kan virksomheder der udvikler offentlige digitale selvbetjeningsløsninger drage fordel af at kombinere en systemcentreret og en brugercentreret tilgang til udviklingen af offentlige digitale selvbetjeningsløsninger og hvordan påvirker dette kvaliteten af disse systemer?"

Både single- og multicasestudier er blevet gennemført for at undersøge udviklingsprocessen af offentlige digitale selvbetjeningsløsninger. Disse casestudier inkluderede semistrukturerede interviews, en spørgeskemaundersøgelse samt en indholdsanalyse. Brugervenlighedsevalueringer blev foretaget af færdige offentlige selvbetjeningsløsninger for at opnå en forståelse for kvaliteten af disse løsninger.

I denne afhandling drags følgende tre konklusioner. For det første anvender virksomhederne der udvikler de offentlige selvbetjeningsløsninger primært en systemcentreret tilgang med fokus på de tekniske aspekter af løsningerne. Synet på borgerne er at de mangler motivation til at anvende de offentlige digitale selvbetjeningsløsninger. Kvaliteten af disse løsninger er lav set fra borgernes synspunkt, hvilket er i overensstemmelse med at borg-

erne ikke prioriteres og ikke involveres i hverken design- eller udviklingsprocessen.

For det andet, mangler virksomhederne viden omkring brugercentrerede designteknikker som eksempelvis Personaer. Sagsbehandlere har delvist været involveret i design- og udviklingsprocessen, hvilket medførte at de offentlige digitale selvbetjeningsløsninger blev udviklet med fokus på at forenkle sagsbehandlernes arbejdsgange samt gøre deres arbejde lettere. Interviewpersonerne fra virksomhederne som udvikler de offentlige digitale selvbetjeningsløsninger udtalte at de gerne vil anvende en mere brugercentreret tilgang til at udvikle disse løsninger, men at de anså at dette ville forøge udviklingsomkostningerne, men til gengæld mente de også at hvis brugerevalueringer af de færdigudviklede offentlige digitale selvbetjeningsløsninger blev obligatorisk ville virksomhederne være tvunget til at anvende en mere brugercenteret tilgang til udviklingsprocessen.

For det tredje, var en del af motivationen for at digitalisere offentlige selvbetjeningsløsninger at reducere de administrative omkostninger. En rapport fra 2016 udført af Rigsrevisionen viser at digitaliseringen af post fra offentlige myndigheder til borgere og virksomheder kun har resulteret i en besparelse på 20% af det forventede beløb. Denne besparelse stammer udelukkende fra en reducering af portoudgifter. Den forventede reduktion af lønudgifter er ikke blevet opnået. Disse manglende resultater har betydet at kommuner er begyndt at udvikle strategier for at inkludere borgerne i de fremtidige digitaliseringsprocesser. Disse nye strategier om at inkludere borgerne er i overensstemmelse med konklusionerne i denne afhandling.

I denne afhandling er adskillige forhindringer blevet identificerede i forhold til at kunne kombinere den for øjeblikket anvendte systemcentrerede tilgang med en mere brugercentreret tilgang. Hvis disse forhindringer bliver fjernet vil denne kombinering være fordelagtig. Involveringen af sagsbehandlere i udviklingsprocessen har vist sig at lede til et forøget fokus på at tilføre værdi for sagsbehandlerne ved at udvikle offentlige digitale selvbetjeningsløsninger med fokus på at simplificere deres opgaver og arbejdsgange. Kombineringen af den systemcentrerede og brugercentrerede tilgang kan fastholde et fokus på at udvikle funktionelle og tekniske løsninger som også kunne øge værdien og brugervenligheden for både sagsbehandlere og borgere.

Acknowledgments

Had someone told me ten years ago I would conduct a PhD I would not have believed it, and now I have just finished writing my thesis. Taking this path has been fun, but also challenging, and many people have contributed in their own way to me getting this far.

First of all, I would like to thank my supervisor Jan Stage for providing me with the opportunity to go on this incredible journey that I have been on for the past years, both as a research assistant and while conducting a PhD. I think it is fair to say that I have not always been an easy student, but I have learned a lot from you.

I would also like to thank Marta Larusdottir – my collaborator and co-supervisor in Reykjavik University in Iceland; you have been a good teacher and a good friend as well.

Helle S. and Helle W., thank you for helping me navigate the administrative bumps on the road. I appreciate the time you have spent with me and on my behalf. Also, thanks to KGO, Peter and the members of the HCC group involved in providing me with this opportunity. I am very grateful to all of you.

To Nis, Frank, Rikke and Michael – my office mates these past years, it has been a pleasure. I respect each one of you as the unique, independent and great people you are.

Lise, Anders, Dimitrios and John, thank you for the helpful talks and discussions. I have learned a great deal from you, and it has meant more to me than you could possibly know.

To Mik, MAV, and Kenneth, my thanks for the MC-rides, tours, bike-repair sessions, and good times we have shared these years. Those rides gave me the breaks I needed from thinking about and working on my thesis.

To Maria, Martin and Thomas, thank you for being there as a listening ear when I needed to talk.

To Michael, Søren, Lasse, Sebastian, Nikolaj and Martin, believe it or not, you actually helped me go the last mile. Your company, hospitality and sense of humour gave me the strength to continue when it was getting really tough and I felt like giving up. I am very grateful to you guys.

To the FLAN-Crew, the Fklub, and the Fklub members. The Fklub is certainly a great source of fun, and I have been a proud member for many years. My gratitude to all the people I have met and talked to over the years, with whom I have had many weird, fun or educative conversations while enjoying a beer.

I would also like to thank my family and in-law family, you have influenced me positively and been part of my life for a very long time.

A special thanks to my mother, Anne, and my aunt, Kisser, for supporting me in achieving my goals. Stubbornness runs in the family, and I am proud of that.

To my husband and LaTeX-guru, Mads: So, now it is my turn to write acknowledgements for a PhD thesis. I knew it was difficult for you when you wrote your thesis, and to the best of my ability, I tried to make everything else as easy for you as possible during that time. Thank you for doing the same for me; thank you for your patience and hard work, I know this has been tough on you too, and I am sure that living with me has not always been easy. It sometimes felt like winter was coming, but now I'm hoping for spring. I love you - always.

I would like to dedicate this thesis to my grandparents, Margit and Erik, and my grandmother Grete, who all died many years ago but had a significant influence in my younger years. Thank you for showing me how to become a strong and independent woman. I still miss you all.

Thesis Details

Thesis Title: Combining a System-Centred and a User-Centred Approach in the Development of Public Self-Service Applications

PhD Student: Jane Billestrup

Supervisor: Professor Jan Stage, Aalborg University

The main body of this thesis consists of the following papers:

1. Billestrup, J., and Stage, J. (2014). "E-government and the Digital Agenda for Europe: A Study of the User Involvement in the Digitalisation of Citizen Services in Denmark". International Conference of Design, User Experience, and Usability. Springer International Publishing.

2. Billestrup, J., Stage, J., Nielsen, L., & Hansen, K. S. (2015). "Creating and Using Personas in Software Development Practice". In International Journal on Advances in Software. Springer Berlin Heidelberg.

3. Billestrup, J., Bruun, A. and Stage, J. (2015). "UX requirements to public systems for all: Formalisation or innovation." INTERACT 2015 Adjunct Proceedings: International Conference on Human-Computer Interaction. University of Bamberg Press.

4. Billestrup, J., Larusdottir, M., & Stage, J. (2016). "Four Public Self-Service Applications: A Study of the Development Process, User Involvement and Usability in Danish public self-service applications". International Journal on Advances in Software.

5. Billestrup, J., Stage, J. & Bruun, A. (2017). "The Usability State of Nine Public Self-Service Applications in Denmark". International Conference of Advances in Computer-Human Interaction.

6. Billestrup, J., Bruun, A., & Stage, J. (2016). "Usability Problems Experienced by Different Groups of Skilled Internet Users: Gender, Age, and Background". In International Conference on Human-Centred Software Engineering. Springer International Publishing.

This thesis has been submitted for assessment in partial fulfillment of the PhD degree. The thesis is based on the submitted or published scientific papers which are listed above. Parts of the papers are used directly or indirectly in the extended summary of the thesis. As part of the assessment, co-author statements have been made available to the assessment committee and are also available at the Faculty.

Contents

Chapter 1

Introduction

Before the IT and Internet era, governments communicated with their citizens through postal mail. At municipality offices, citizens could get the information and help they needed to fill out applications for government services like acquiring a new national health service medical card or enrolling a child in daycare. At the postal offices in Denmark, citizens could obtain a physical folder containing all forms needed to register an address change; the completed forms were sent to the municipality office by postal mail or hand-delivered to the office of the municipality.

Today, all of this information and these applications are available to and submitted by citizens, online. In Denmark, all mail from government agencies to citizens is delivered to a special email account called E-Boks (E-Boks, 2017).

Over the past few decades, both corporations and governments have gone through significant processes of digitalisation, moving from manual paper-based to fully digitalised working procedures. The purpose of these processes of digitalisation has been to use "digital technologies to change a business model and provide new revenue and value-producing opportunities" (Gartner, IT). When this process of digitalisation is applied by governments, it is referred to as e-government (Moon, 2002), and the focus has mainly been on saving money for the governments. In Denmark, this strategy included citizens serving themselves through the use of public self-service applications (Kombit, 2011).

The latest digitalisation process in Denmark was part of a digitalisation strategy founded in 2011 and included all countries in the European Union. Known as the Digital Agenda for Europe, it is described as "a roadmap for bringing the benefits of a digital society and economy to Europe's citizens" (Ringrose, 2011). This agenda contains strategies for the digitalisation of five areas collectively referred to as the Digital Economy and Society Index, or

DESI. The five focus areas are: connectivity (broadband infrastructure and quality), human capital/digitalisation skills (user IT skills), use of the internet by citizens, integration of digital technology by businesses, and digital public services (European Commission, 2017). The program founders reasoned that providing fast internet, increasing citizens' IT and internet skills, and offering digitalised e-government services and public self-service applications would improve the economy and enhance business in the European countries (Ringrose, 2011). Denmark has been recognised as an early adapter and is one of the European countries furthest along with the implementation of the strategies from DESI (European Commission, 2016). Countries such as Germany are looking at the Danish progress to learn how to implement the use of public self-service applications and e-government (Version 2, 2017a) .

Though Denmark is a first-mover in the digitalisation process and is one of the countries at the top of the scale, the transition has not been smooth for its citizens. Interest groups of citizens have been complaining for years about the low usability of the public self-service applications (e.g., (Prosa, 2011; Ældresagen, 2015)) and even criticism from within the government agencies (Version 2, 2014b). To avoid further criticism and to acquire the estimated savings of the digitalisation process, the focus has started to change from a system-centred approach focusing solely on the technical aspects of these applications towards a more user-centred approach.

This thesis presents studies of user involvement in the development process of public self-service applications and how a focus on the technical aspects can be combined with the user-centred aspects of the development processes.

In this chapter, the motivation, the research questions, and the structure of the thesis are described. Key concepts used in this chapter will be defined and discussed in Chapter 2.

1.1 Public Self-Service Applications

E-government has been on the agenda around the globe since the late 1990s and can broadly be described as IT applications used to simplify or improve transactions or communication between governments and other actors such as citizens, businesses or other governmental agencies (Moon, 2002). In this thesis, public self-service applications are seen as a subset of the broad term of e-government. In Denmark, most public self-service applications are provided by the municipalities, but in a few areas applications are provided by government ministries. For example, the public self-service application for sending a tax return is provided by the Ministry of Taxation, and the registration of deeds is provided by the Ministry of Justice.

Public self-service applications are replacements for the traditionally paper-

based forms or PDF-forms that can be printed by the citizens, filled out by hand and sent to the municipalities or governing agencies by postal mail (Rigsrevisionen, 2013). These public self-service applications are used by citizens to serve themselves if they need to apply for a government service, like a new driver's license or to enrol a child in daycare or school. The idea is that all information is filled out electronically by the citizens, then received and processed digitally by caseworkers in the municipalities. This process has led to citizens' centres being downsized or closed accordingly (FFSO, 2014).

In Denmark, public self-service applications are being developed by software companies and sold to the municipalities. For each citizen the relevant public self-service applications are available through the public website `www.borger.dk`, a name literally meaning "citizen.dk", which is a citizen's portal designed as the primary entry-point to public self-service applications in Denmark, both on the municipality and ministry level. All Danish public self-service applications use the same design style as the hosting website, including colours and fonts. Figure 1.1 shows the English version of the front page of `www.borger.dk`, which in the English version is called `www.lifeindenmark.dk`.

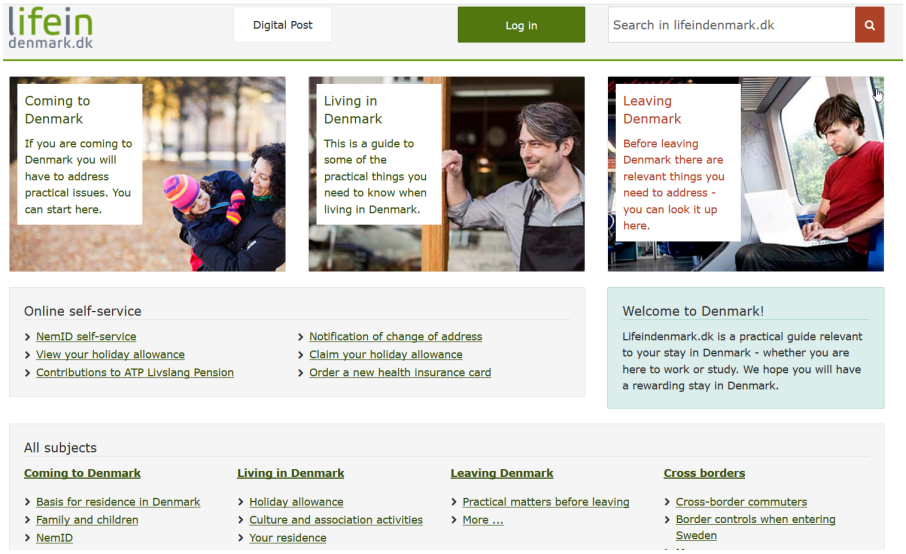

Figure 1.1: English version of the frontpage of `www.borger.dk`.

From the citizen's perspective, the public self-service applications appear to be integrated with the website, but each citizen will actually be directed to the public self-service applications provided by the municipality to which they belong. This means that two citizens belonging to different munici-

palities might be directed to different public self-service applications when enrolling a child in daycare, if those municipalities have bought public self-service applications from different software companies.

There are two purposes for introducing mandatory public self-service applications. The first is to provide citizens with "better possibilities for contacting the municipalities when it suits their schedule" (Kombit, 2011). Second, public self-service applications are considered a way of saving money, but the estimated savings are dependent on citizens using the applications. In some service areas, public self-service applications have been available for the citizens to use for more than a decade, but their use was optional. The organisation of the municipalities in Denmark conducted a study about the usage of these applications and found that some were rarely used (Kombit, 2011).

To force citizens to use public self-service applications, and municipalities to enforce the usage, it was decided that all citizens who were able should use the self-service applications and would no longer be allowed to fill out paper forms at the citizen centres (Kombit, 2011). After 2012, only citizens without the ability to use a computer could be exempted from this rule. The goal was that by the end of 2015, 80% of all communication between citizens and municipalities would be conducted through e-government and public self-service applications (Kommunernes Landsforening, 2012b). A plan for the digitalisation of 88 public self-service applications in 44 self-service areas followed this decision. These public self-service applications were released in four stages, one every year, over the years 2012-2015.

Eight months after the release of the first mandatory public self-service applications, a survey from Rambøll showed that citizens supporting the use of public self-service applications had gone down from 35% in 2012 to 28% in August 2013 (Rambøll, 2013). The reason for this drop in support has been related to the usability of the new public self-service applications being too low (Version 2, 2013). The survey concluded that more focus needed to be put into understanding the citizen's needs when developing these applications (Rambøll, 2013; Version 2, 2013).

1.2 Development of Public Self-Service Applications

Traditionally, public self-service applications and e-government services in Denmark have been developed with a contract stating a fixed specification of the requirements. Companies would then bid to get the contract to develop the system, and only one company would be awarded the contract. Historically, IT solutions for public administration and public self-service applications in Denmark have been developed by one company that was created

by a consolidation of the municipalities' own internal IT organisations. The purpose was to support the municipalities by developing the applications and solutions needed by the municipalities. This company was owned by the Danish municipalities through the countrywide organisation of the municipalities and handled by the joint IT organisation of the municipalities. In 2008, it was sold and privatised (Computerworld, 2008; Wikipedia, 2017). The sale of the company technically ended the state of monopoly, but only a few other companies gained market share in Denmark, effectively maintaining the monopoly. This state of monopoly was blamed for these public applications being overpriced and of low quality (Kombit, 2011).

In 2011, as the plan for the development and deployment of public self-service applications from 2012-2015 was introduced, initiatives were taken to reduce the monopoly. These included the introduction of companies competing to sell a fully developed application to the municipalities and providing each of the 98 municipalities the ability to choose freely between all developed public self-service applications in each public self-service area. The philosophy behind this change was that "a healthy competition will enhance the probability of the municipalities acquiring innovative solutions at reasonable prices" (KL, 2011). The purpose was to be able to acquire public self-service applications more cheaply and of a higher quality than previously (Kombit, 2011).

Criticism followed the release of the first mandatory public self-service applications for citizens. The applications were critiqued for being low on usability and unintuitive. The criticism came from the public, the media, citizens' organisations, IT professionals, and usability experts (Ældresagen, 2015; Elkjær, 2011; C. Nielsen, Stage, Bruun, & Pedersen, 2010; Politiken, 2013; Prosa, 2011). This criticism was followed by a report from the National Audit Office in Denmark about the user involvement and usability of the public self-service applications released in 2012. The report concluded that the usability was generally too low and recommended that more focus be put on involving end-users in the development process and enhancing the usability of public self-service applications by conducting usability evaluations (Rigsrevisionen, 2013).

Public self-service applications have been accessible to Danish citizens for years but were optional to use. This meant that if citizens were not able to use a public self-service application, they could go to the citizens' centres and fill out the application on paper with assistance from the employees. In 2012, using these applications became mandatory.

Receiving application assistance at citizens' centres became less of an option after the introduction of the mandatory use of public self-service applications. This led to a counter-claim from the public for public self-service applications focused on usability (Version 2, 2014a). The joint IT organisation of the municipalities responded by setting a goal to change the procedures

for the development of public self-service applications. This goal meant that companies should involve stakeholders like caseworkers and citizens in the design and development process on a regular basis. The purpose was to change the focus, primarily of the technical requirements, to include the end-users and their needs.

In this thesis, the technical perspective of the user-needs is termed a system-centred development approach. In the past, these systems and applications were developed based on a fixed specification of requirements, and the focus during the development process was mainly on the technical requirements. From a technical perspective, in a development process with fixed requirements, the end-users are not necessarily seen as assets to the design and development process, as their needs are already documented in the specification of the requirements. End-user involvement on a regular basis is described as both difficult and time-consuming, as the focus is mainly on finding the optimal way to implement the technical requirements (Oostveen & van den Besselaar, 2005; Oppermann, 2005).

1.3 Usability of the Public Self-Service Applications

Prior to public self-service applications becoming mandatory in Denmark, the focus of developing these applications was mainly on the technical quality, including the features and robustness of the public self-service applications. When use was declared mandatory, citizens' organisations demanded that the public self-service applications be developed with a focus on usability for the citizens.

Citizens had been accustomed to having a choice of whether or not to use public self-service applications. As it became mandatory, they lost those options.

Making the use of public self-service applications mandatory has raised concerns about the lack of usability of these mandatory public self-service applications. The concern is that a difficult form completion process could jeopardise the expected cost savings of conducting this process of digitalisation of public self-service applications (Molich, 2014).

Other countries have experienced similar claims and criticism when conducting a digitalisation of e-government, citizens' services, and public self-service applications, including South Africa and Taiwan (Pretorius & Calitz, 2012; Wangpipatwong, Chutimaskul, & Papasratorn, 2008).

Poorly designed e-government websites or public self-service applications lacking usability could prevent citizens from consistently using these sites or applications, or send filled-out applications containing incorrect information (Wangpipatwong et al., 2008). It could also lead to citizens calling the help

hotline frequently if they do not understand how to fill out the public self-service applications (Molich, 2014). These scenarios create a risk of losing the expected savings of implementing mandatory public self-service applications (Elkjær, 2011; Molich, 2014; C. Nielsen et al., 2010).

If a digital application has a high degree of usability, citizens are more likely to accept the public self-service applications and keep using them (Clemmensen & Katre, 2012; Huang & Benyoucef, 2014).

The possibilities of implementing a user-centred focus in the development of public self-service applications or e-government websites are documented in several studies (e.g., (Eriksson, 2013; Pretorius & Calitz, 2012; Wangpipatwong et al., 2008)). Different measures have been taken by different countries to encourage a user-centred approach in the analysis, design and development phases of public self-service applications, and e-government. The UK created ten principles to use during the development and design process of their e-government websites (GOV.UK, 2012). Finland developed benchmarks for how well the system should perform when tested on real users (Tarkkanen & Harkke, 2015), and Denmark has developed a set of Usability criteria and a user journey (Kombit, 2014). The Danish initiatives are described in more detail in Contribution 3.

It has been estimated that the government of the UK has saved approximately £42 million by focusing specifically on ensuring usability of their e-government website, `www.gov.uk` (McKinsey, 2014; GOV.UK, 2012). These estimated savings show that the potential for savings is present in public digitalisation and e-government, and also that usability is an essential factor to consider (Dansk Industri, 2016).

1.4 Research Questions

In this thesis, the use of a user-centred design approach to the development of public self-service applications in Denmark and the quality of these public self-service applications from the citizen's perspective, will be explored. The following general research question has been defined:

General Research Question. *To what extent can companies developing public self-service applications benefit from combining a system-centred and a user-centred approach, and how does that affect the quality of the systems?*

This general research question has been divided further into two research questions:

Research Question 1. *To what extent do companies developing public self-service applications employ a system-centred approach, and how does that affect the quality of the systems for the citizens?*

This research question refers to the general research question in regards to exploring the practices of the system-centred design and development process of public self-service applications.

Research Question 2. *To what extent can companies developing public self-service applications employ a user-centred approach in the development process, and how does that affect the quality of the systems for the citizens?*

This research question refers to the general research question in regards to examining and evaluating the implementation of user-centred design in the development of public self-service applications.

1.5 Structure of the Thesis

This thesis consists of five chapters. The first chapter provided the introduction; next, Chapter 2 presents the conceptual background for this thesis, which defines concepts key to the research questions. Chapter 3 describes the six contributions, which are all published papers. Chapter 4 outlines the research methods used in this thesis. Finally, Chapter 5 presents the conclusions of this thesis and answers the research questions, including the limitations and suggestions for future work. The contributions are included in the appendix.

Chapter 2

Conceptual Background and Key Concepts

In this chapter, the conceptual background of this thesis will be described. The aim is to define key concepts and to discuss literature related to the research questions presented in Chapter 1.

2.1 Product Quality and Process

In this subsection, the terms used to define quality in this thesis will be described. Quality has been studied for decades in regards to quality of both manufactured products and software (e.g., (Bevan, 1999; Garvin, 1984)).

Alexander (1964) stated that, "A good design is characterised by the absence of weaknesses". In the context of software development, an absence of weaknesses can be linked to the quality of the software, since the more weaknesses there are, the lower the quality is. Shneiderman (2003) described the change in the view of computers and users as "old computing" and "new computing", where "the old computing is about what computers can do, the new computing is about what people can do". McCall, Richards, and Walters (1977) divides software quality into 11 quality factors, including correctness, reliability, efficiency, maintainability, testability, and usability. These quality factors can be roughly divided into two categories: technical quality and use quality. The technical quality of the software is what lies behind the user interface and the implemented features, referred to as the quality of system in this thesis. Use quality is the user's ability to use the system, and the usability of the software is named quality of use in this thesis.

2.1.1 Quality of System

Quality of system focuses on the technical quality of a system. Traditionally, quality measurements were mainly applied to manufactured products, and the quality of products was considered measurable by the quantity of desired or preferred ingredients or attributes as described by Abbott (1956)) and Garvin (1984).

In software development, the quality of the software relies on technical quality, or how the software is constructed internally (McCall et al., 1977). It is assumed that measuring and controlling internal product properties (internal quality indicators) will result in improved external product behaviour (Pfleeger & Kitchenham, 1996).

Assessing the quality of manufactured products involves determining to what degree a specific product conforms to the requirements (Crosby, 1979; Gilmore, 1974), and deviations are considered a lowering of the quality (Garvin, 1984). In software development, quality is assessed by how closely the software meets a specification of requirements and if "the product was constructed 'right the first time', to avoid the costs associated with rework during development or after delivery" (Pfleeger & Kitchenham, 1996).

Quality measuring models for software development include quality factors such as maintainability, flexibility, testability, and efficiency (B. W. Boehm, Brown, & Kaspar, 1978; McCall et al., 1977; Dromey, 1995). Wong goes on to describe software quality as the lifespan of a piece of software (Wong, 2006).

No differentiation is made between the end-users and customers, and it is implied that their needs and wants are standardisable and aligned.

Software quality relies on the lifespan of a system along with internal quality indicators, including the amount of rework or defects in the product and whether the software is in agreement with the specifications of requirements and standardisations.

These views of quality have been criticised since the 1970s when computer systems were implemented in working life and have been described as Tayloristic and capitalistic. Management's focus has been described as merely profit oriented, and excluding the users or workers from the development process was seen as a means of keeping the workers under control (Ehn & Kyng, 1987). A movement criticising these quality views, named the Scandinavian tradition, was based on a "profound dissatisfaction with the shortcomings of a traditional, mechanistic approach to system development – and some of the attempts at overcoming them" (Kyng, 1996).

Management control has traditionally been seen as the answer to achieving a higher quality of both system and services as well as profitability (Klein & Alvarez, 1985). Efficiency was the dominant work value, but was perceived as only achievable by using tight control systems and fractionated work (Mumford, 1985). This has since been disproved as involving users

in the design process has been shown to increase both productivity and the quality of the system (Mumford, 1985; Schuler & Namioka, 1993).

2.1.2 Quality in Use

Quality in use focuses on the quality of a software system and user interface from the user's perspective. Quality from the users' perspective can be defined as "the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs" (ISO8402, 1994). Quality in use involves both whether the user receives value in regard to their specific needs and use-situations and providing the user value for money.

To provide value for money, low manufacturing costs and reasonable sales prices are essential (Feigenbaum, 1961; Garvin, 1984). Broh (1982) defines this perspective on quality as "the degree of excellence at an acceptable price and the control of variability at an acceptable cost". In this view on quality, it is implied that the quality of a product will decrease from the user's perspective if the sale price exceeds the value it will bring to the users, meaning that the development of specific features should focus on whether these features provide more value than the price of acquiring it (Pfleeger & Kitchenham, 1996).

The concept of quality for users derives from the premise that consumers are different and have different wants and needs. "Quality is the degree to which a particular product satisfies the wants of a specific customer" (Gilmore, 1974) and is considered to be based on each consumer's preferences (Garvin, 1984). Quality is defined as the degree to which the software is meeting the concrete, personalised needs of the users (Pfleeger & Kitchenham, 1996).

When describing quality in use, the terms "customer" and "users" are both used. However, no distinction is made between these terms. In this thesis, the terms customer and user are differentiated, as it is recognised that the customer might not be a user of the software and the user might not be the customer.

In this thesis, the users are the people using the software or application, and the customers are the people paying for the software or application. This differentiation between users and customers was shared by Nygaard and is derived from the Scandinavian tradition. The Scandinavian tradition began with Nygaard and the NJMF project in the nineteen seventies in Norway (Nygaard, 1979). This project was followed by the Swedish DEMOS-project (Ehn & Sandberg, 1983) and the Danish DUE-project (Kyng & Mathiassen, 1982). These three projects all had the overall purpose of educating users to provide competent input on the specifications of requirements in regards to the implementation of IT in the users' daily work. This was followed by the UTOPIA-project in the 1980s (Ehn & Kyng, 1987), which focused on

the development of new technology for users. Though the approach was initially intended for workers, it has also been found applicable for office work (Mumford, 1983) and consumer goods and services (Ehn & Kyng, 1987).

The original intention was to oppose the tendencies of systems in which humans were incorporated as programmable and mechanical production factors by democratising workplaces and introducing joint decision making (Nygaard & Bergo, 1975). The problem is described as a lack of freedom for each worker, as capital owners hold power over resources, production process, design and use of technology, and limiting an individual's autonomy at work (Ehn, 1993). The primary focus of the Scandinavian tradition was to introduce workplace democracy, but the focus has shifted towards more emphasis on use values, like usefulness and quality in use (Ehn & Kyng, 1987; Greenbaum & Kyng, 1991). It became clear that in order to meet the users' requirements and needs, those affected by a design should be involved in the design process (Ehn, 2008; Tollmar, 2001).

Involving users in the design process created value for the users by increasing the quality of working life and increasing job satisfaction (Ehn & Kyng, 1987). The focus on creating value for the users was later emphasised by Cockton and the HCI-community. Cockton stated that adding value to the users was crucial for acquiring quality in use (Cockton, 2004).

In the HCI literature, quality in use is shown by applying usability techniques to measure the quality of the software for the end-users. Nielsen defined usability as "a quality attribute that assesses how easy user interfaces are to use" (J. Nielsen, 1994a). This definition has been clarified further by the ISO standardisation of 1998, which states that the focus needs to be "the extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and stasifaction in a specified context of use" (ISO9241, 1998). The context of use is stated to be explicitly relevant when applying usability measures to describe the quality in use of software (Bevan, 1995; Macleod, 1994; J. Nielsen, 1994b).

The level of quality in use is dependent on whether a system creates value for the users, and usability measures can be used to measure quality, as poor usability can destroy the use-value. Nonetheless, usability initiatives cannot secure value on their own, as different users have different needs (Cockton, 2004).

2.1.3 Summary

The meaning of quality of system and quality in use applied in this thesis can be summarised as follows.

Quality of system:

- focuses on the technical quality,

- determines whether the software conforms to the specification of requirements,
- controls internal product properties, resulting in improved external product behaviour.

Quality in use:

- focuses on the quality of the software and user interface from the user's perspective,
- is determined by whether a product or software provides value for the users depending on their own personalised needs and use situations,
- considers customers and users to be different entities.

2.2 Design and Development Process

The following sub-sections describe system-centred design, user-centred design and participatory design. In system-centred design, the user is seen as the object and is not involved in the design and development process. In user-centred design, the user is seen as a subject and is studied and to some degree involved in the design and development process. Participatory design views the user as a partner fully involved in the design and development process.

2.2.1 System-Centred Design Process (user as object)

In system-centred design, quality of the system is the primary emphasis. Whether a design meets the specification of requirements is shown by testing, verification, and validation of the features and technical aspects (Hartson & Hix, 1989). System-centred design focuses on whether the software contains the features or artefacts described in the specification of requirements (Cockton, 2005).

In the first decades of systems development, users of these systems were mainly programmers or engineers, meaning that the developers of these systems were already in the target user group. Thus, developers already had knowledge about the domain and use situations and were able to speak for the end-users and their needs (Bødker, Grønbæk, Bannon, & Grudin, 1993). Now software is developed and designed for all types of people, of all ages and educational backgrounds (Rubin & Chisnell, 2008).

Since the user-group of software was expanded from mainly programmers and engineers, the focus changed to developing systems that would prevent the users from making critical mistakes or breaking the system, described by Wasserman as "idiot-proofing the system" (Wasserman, 1973).

Wasserman's concept of idiot-proofing a system shows a feature and task-oriented focus in which users are objectified and standardised. This system-centred design approach, where the users are standardised and seen as the object, is also seen when users are only involved in the specification of requirements to define features and artefacts and not in determining how these features work for the users, if the system or application is usable for the end-users or if it provides value to the user in the given context (Cockton, 2005).

The same principle applies to Nielsen's ten usability heuristics (J. Nielsen, 1995), which also has a feature-oriented focus. These heuristics provide more of a how-to guide about how and where to place these features, and less on whether the users can use the system or if using the system brings value to the users.

In spite of this criticism of the system-centred approach, Dillon, Sweeney, and Maguire reported that in 1993, the IT development in Europe was primarily led from a system-centred perspective.

Principles like Wasserman's focus on "idiot-proofing" a system or Nielsen's ten usability heuristics are described as feature-oriented and reduce users into something that a system should protect itself from by preventing the users from making mistakes. Following guidelines such as Wasserman's or Nielsen's provides a way to do that. Cockton emphasises that this guideline-based approach does not work in reality, mainly because a system should be focused on providing value to the users and following guidelines means that objects are considered independently of the use-context (Cockton, 2004). The system-centred design approach has also been criticised for inadequate market research, leading to a lack in understanding of the users (R. G. Cooper, 1999; van der Panne, van Beers, & Kleinknecht, 2003).

2.2.2 User-Centred Design Process (user as subject)

User-centred design is a broad term for developing software with an end-user oriented focus. Described both as a philosophy and a variety of methods, it is seen as a rationalistic view of end-user development (Abras, Maloney-Krichmar, & Preece, 2004). Gulliksen et al. define user-centred design as "a process focusing on usability throughout the entire development process and further throughout the system life cycle" (Gulliksen et al., 2003). The origin of user-centred design is uncertain. Sanders and Stappers describe user-centred design as derived from a North American tradition (Sanders & Stappers, 2008), but Gulliksen et al. describe user-centred software design as coming from the Scandinavian tradition and participatory design (Gulliksen et al., 2003). The definition of the concept of user-centred design is also unclear (Carroll, 1996; Gulliksen et al., 2003; Karat, 1997; Kujala, 2003). J. Iivari and Iivari attribute this lack of clarity in part to the incorporation of different methods (J. Iivari & Iivari, 2011). These methods include prototyping (Bødker

& Grønbæk, 1991), evolutionary delivery (Keen & Scott, 1978), socio-technical design (Bostrom & Heinen, 1977), user participation (Mumford, 1983), participatory design (e.g., Greenbaum and Kyng (1991)) and usability engineering (Karat, 1997; Mayhew, 1999; J. Nielsen, 1994a).

In user-centred design, the users are essential and a focal point throughout the design and development process. User-centred design techniques are to some degree known, and used in the industry. Venturi, Troost, and Jokela (2006) found that the most frequently used techniques for involving users are interviews, usability evaluations, hi-fi prototyping, and low-fi prototyping.

Methods like Personas and Scenarios or other types of user representations are used less frequently by practitioners, although Personas has been recognised as being useful when targeting larger heterogeneous user-segments.

The users can be either the subject that is being studied through the use of techniques, such as those mentioned above, or they can be directly involved in the specification of requirements, the design process, and the development process. User-centred design provides the advantage of efficiently collecting data for understanding the users and designing for their needs (Spinuzzi, 2005). The purpose is to develop software that provides value for the users (Cockton, 2004).

User-centred design can also be conducted without involving actual users, as other techniques can be used to represent the users (Carroll, 1996). Users can be involved only a few times or continually throughout the design and development process (Abras et al., 2004; N. Iivari, 2004).

Involving end-users has been found to have numerous positive outcomes, including higher product quality, decreased time used for research and design, products better matching the needs and preferences of the end-users, and increased end-user satisfaction (Kujala, 2003; Steen, Kuijt-Evers, & Klok, 2007).

Though user involvement is beneficial, it also has some weaknesses. Users might not be aware of their actual needs or be able to articulate these needs (Steen et al., 2007; van Kleef, van Trijp, & Luning, 2005). It has been argued that users express their preferences based on familiarity with existing products (Steen et al., 2007; van Kleef et al., 2005). These existing products can be a prejudicial factor and have a biasing effect on the designers when users express needs based on what they know instead of what they need (van der Panne et al., 2003).

Over-involving users when designing for a broad heterogeneous user segment is also described as problematic, as basing a design on a few end-users might result in a final product that is only relevant to a narrow segment of potential users (Stewart & Williams, 2005).

Researchers using participatory design criticise user-centred design for its view of the end-users. Sanders and Stappers describe users in user-centred design as being passive and providing limited contributions, mainly serving

"to give their opinions about product concepts that were generated by others" (Sanders & Stappers, 2008).

2.2.3 Participatory Design Process (user as partner)

Participatory design derives from the Scandinavian tradition led by Kristen Nygaard in the 1970s. In participatory design, users are seen as the experts (Sanders & Stappers, 2008; Spinuzzi, 2005). Users are considered equal to designers, and all design has to be conducted with the users. Designers are mainly seen as technical consultants (Sanders & Stappers, 2008; Schuler & Namioka, 1993), but the philosophy is that designers can learn about the use contexts from the users, and the users can learn about the technical options from the designers (Kensing & Blomberg, 1998). Participatory design includes both theories, practices, and studies involving the end users in the design process (Das & Svanæs, 2013). In participatory design, involving the intended users is seen as crucial for attaining a good design and increasing the chance of developing a system which is usable and can be well integrated into work practices (Kensing & Blomberg, 1998).

As participatory design evolved from the Scandinavian tradition, there initially was a strong focus on involving the workers and excluding the managers from the design process in hopes of providing the workers with a voice in regards to a design that would have an impact on their working life. Management involvement was seen as a risk that could have a silencing effect on the workers, hence undermining the intentions and benefits of participatory design (Kensing & Blomberg, 1998). Over time, this restriction has been loosened, as studies have concluded that all user groups and people affected by the system, including managers, need to be involved in the design process for the design to be successful. Involvement of managers has also been shown as crucial for customers to be willing to invest in the projects (Kensing, Simonsen, & Bødker, 1998; Korpela et al., 1998; Gärtner, 1998).

Techniques for user-involvement in participatory design are basically the same as in user-centred design. Kensing and Munk-Madsen described participatory design methods like observations, interviews, workshops, prototyping, and think-aloud (Kensing & Munk-Madsen, 1993), all methods also applied within user-centred design. The main difference is in the view of the users as either partner (participatory design) or subject (user-centred design) and the purpose of the involvement of the users. Sanders and Stappers provide an overview of the landscape of human-centred design, which is shown in Figure 2.1 (Sanders & Stappers, 2008). This illustration is stylised but still provides an idea of the range of user focus in user-centred design and participatory design respectively, although the illustration is based on user-centred design as derived from the North American tradition.

As described in Section 2.2.1, user involvement has several benefits, but it

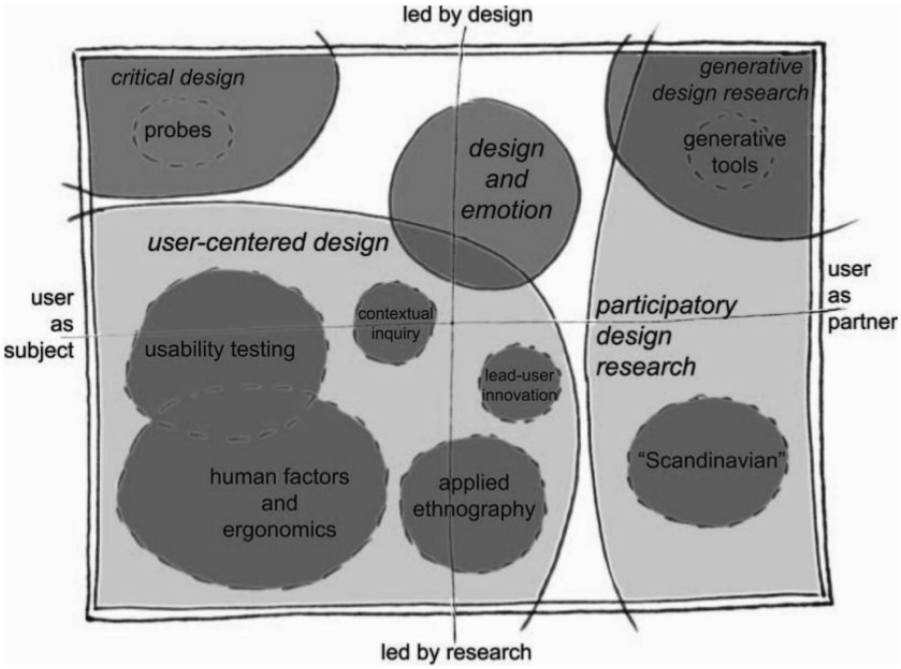

Figure 2.1: The figure shows the landscape of human-centred design and the names of techniques depending on the focus and type of user involvement (Sanders & Stappers, 2008).

can be challenging to describe and formalise the knowledge of the end-users (Das & Svanæs, 2013; Spinuzzi, 2005). It has been argued by Hekkert and van Dijk (2001) that a significant degree of user involvement can have some side effects, such as decreasing the vision and creativity of the designers, as users rarely have an understanding of their future needs. Henry Ford supposedly said, "If I had asked people what they wanted, they would have said faster horses". This is in line with the conclusions from Hekkert and van Dijk (2001) that users might not have the ability to be innovative and envision new possibilities, but are instead bound by current practices and technologies.

2.2.4 Summary

The view applied in this thesis of the system-centred design process (user as object), user-centred design process (user as subject), and participatory design process (user as partner) is as follows.
System-centred design process (user as object) is defined as:

- focusing on "idiot-proofing" the system,
- standardising users,
- focusing on features and technical requirements.

User-centred design process (user as subject) believes:

- users are the subjects who are being studied,
- users are in focus throughout the design and development process,
- the focus is on creating value for the end-users.

Participatory design process (user as partner) holds to the following:

- users are seen as the experts,
- involved on equal terms as designers,
- focus is on making a good design that can be well-integrated into work-practices.

2.3 Public Self-Service Applications

A public self-service application is an online version of a paper-based form used to apply to the municipality for a service. The first released public self-service application was literally a digital version of a paper form. An example can be seen in Figure 2.2.

Companies have since been changing this format to a wizard so that citizens only have to add information directly relevant to their application.

The digitalisation of public self-applications in Denmark has been released in four stages in the years 2012–2015 (Kommunernes Landsforening, 2012a). In the first stage in 2012, six public self-service application areas were released within the areas of citizens' services and daycare offers. In the second stage in 2013, 12 additional public self-service application areas within citizens' services were released. In 2014, the third stage, ten public self-service application areas within citizens' services along with technical and environmental areas were released. The fourth stage was rolled out in 2015, with the digitalisation of four public self-service application areas within social services, employment, and technical and environmental areas. The stage plan can be seen in Table 2.1.

Each of these public self-service applications consists of two separate systems: the front-end system, which citizens use to fill out forms and applications; and the back-end system, used by the caseworkers at the municipalities to handle the incoming applications from the citizens.

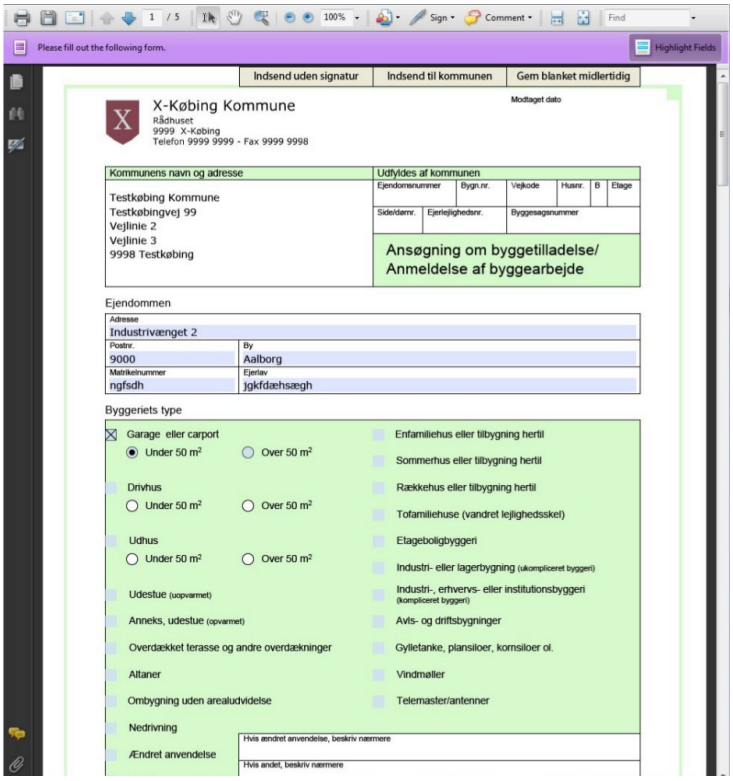

Figure 2.2: The first released public self-service application, which literally was a digital version of a paper form.

The front-end system is used to acquire the information needed from the citizens, including attachments of files. For example, statements from medical specialists might be uploaded if a citizen is applying for assistive technologies.

When a public self-service application has been completed and sent to the municipality, it will appear in the back-end system used by the caseworkers. In this system, caseworkers can either be assigned or assign themselves to handle the incoming applications, and the status of the application is shown.

The user-group of the back-end systems consists mainly of the caseworkers of the municipalities, making this user-group small and homogeneous. In contrast, the user-group of the public self-service applications is all citizens in Denmark, a large and heterogeneous group. In public self-service applications, the primary end-user group will vary depending on each specific application. A public self-service application for changing address is used

by citizens of all ages, but another self-service application such as enrolling a child in daycare is mainly used by citizens in their 20s, 30s, or early 40s, while a self-service application for retirement pension is mainly used by citizens in their 60s and above. No matter which age group is the main user of a specific application, all applications are used by citizens of various educational backgrounds, computer skills, and domain knowledge.

	Public self-service applications area
Stage 1 2012	• Address change • National health service medical card • European health insurance card • Daycare • After-school care • School registration
Stage 2 2013	• Aid for burial • Free day care • Assistive technologies for handicapped or elderly • Exit visa • Unlisted name or address • Reporting of rats • Loan for real estate tax • Letting out facilities • Changing medical practitioner • Marriage certificate • Passport • Drivers' license
Stage 3 2014	• Garbage handling for citizens • Garbage handling for organisations • Construction work • Building permission • Loan for deposit • Registration in CPR • Services in roads and traffic areas • Notification of digging or work on pipelines • Certificates for Lodging • Parking permits
Stage 4 2015	• Personal supplement • Sickness benefits • Sickness supplement • Extended sickness supplement

Table 2.1: Plan for deployment of self-service applications (Kommunernes Landsforening, 2012a).

Chapter 3

Contributions

This chapter presents contributions included in this thesis. Six papers have been included which constitute the research contributions:

1. Billestrup, J., and Stage, J. (2014) "E-government and the Digital Agenda for Europe". International Conference of Design, User Experience, and Usability. Springer International Publishing..

2. Billestrup, J., Stage, J., Nielsen, L., & Hansen, K. S. (2015) "Creating and Using Personas in Software Development Practice". In International Journal on Advances in Software. Springer Berlin Heidelberg.

3. Billestrup, J., Bruun, A. and Stage, J. (2015) "UX requirements to public systems for all: Formalisation or innovation." INTERACT 2015 Adjunct Proceedings: International Conference on Human-Computer Interaction. University of Bamberg Press.

4. Billestrup, J., Larusdottir, M., & Stage, J. (2016) "Four Public Self-Service Applications: A Study of the Development Process, User Involvement and Usability in Danish public self-service applications". International Journal on Advances in Software.

5. Billestrup, J., Stage, J. & Bruun, A. (2017) "The Usability State of Nine Public Self-Service Applications in Denmark". International Conference of Advances in Computer-Human Interaction.

6. Billestrup, J., Bruun, A., & Stage, J. (2016) "Usability Problems Experienced by Different Groups of Skilled Internet Users: Gender, Age, and Background". In International Conference on Human-Centred Software Engineering. Springer International Publishing.

In this research, it has been studied how using a system-centred or user-centred development approach affects the users and the development of public self-service applications. From these views, the development process and quality views of the public self-service applications have been described, from the citizen's perspective.

This corresponds to the two research questions presented in Section 1.4. The matrix shown in Figure 3.1 provides an overview of the relations between contributions where the columns represent the focus when designing public self-service applications. The rows represent the second focus of these studies, whether the development process is studied or the product quality or both.

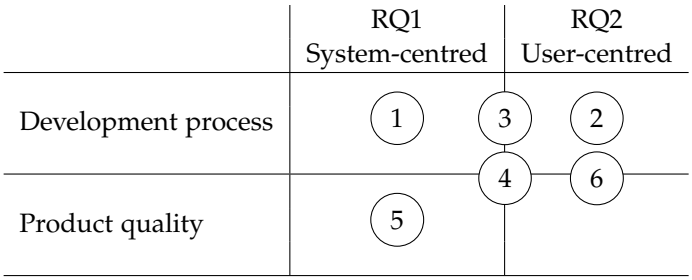

Figure 3.1: Shows the relation between the contributions, and research questions.

3.1 Contribution 1

> Billestrup, J., and Stage, J. "E-government and the Digital Agenda for Europe." International Conference on Design, User Experience, and Usability. Springer International Publishing. (2014).

This contribution examines the current practices of companies developing public self-service applications, as well as the involvement of end-users in the design and development process. This study was conducted in the initial phase of the design and development process of the public self-service areas included in the second stage of the digitalisation of public applications in Denmark.

The data collection began with meeting with the joint IT organisation of the municipalities, followed by interviews with one employee from each of the 11 companies developing public self-service applications for the second stage of the digitalisation process. The interviewed employees were mainly

project managers focusing on the development of the public self-service applications.

The companies varied in size, from 12 employees based in one location in Denmark to approximately 170.000 employees based worldwide, including Denmark. The semi-structured interviews were recorded and later transcribed. The data was analysed using coding.

This contribution provides two main findings. The first is in regard to user groups. The companies describe two different user groups for the public self-service applications: citizens for the front-end system, and caseworkers for the back-end system. The findings of this contribution showed that the companies developing public self-service applications involve caseworkers to some degree in the design and development process. In contrast, citizens were not involved in either the design or the development process, as it was expected the caseworkers would know the abilities and limitations of citizens using the specific types of public self-service applications. It was also assumed that citizens could learn how to use the public self-service applications if they were motivated enough to do so. The argument was that citizens would be more motivated and have less difficulty using public self-service applications if they needed a service from the municipality, such as collecting benefits or enrolling a child into daycare, than if a public self-service application is filled out mainly because it is required by law.

The second finding speaks to how and why these users are involved. The companies primarily involved caseworkers by hosting workshops focused on features and technical aspects. The aim of the caseworker involvement was to describe workflows and processes to ensure the caseworkers would receive the necessary information from the citizens using the public self-service applications. The interviewees also described hosting workshops after releases to discuss change requests and updates based on the caseworker's experiences with citizens using the applications.

This contribution helps to answer the first research question as it describes the current practices of the user involvement in the design and development process of the companies developing public self-service applications. The contribution indicates the caseworkers are involved in the design and development process in order to represent both their own needs and the needs of the citizens. The focus of the involvement is mainly to understand the processes and technical aspects and features that benefit the caseworkers. It was suggested by the interviewees that citizens' difficulties was due to lack of motivation rather than of ability when experiencing problems using the public self-service applications.

3.2 Contribution 2

> Billestrup, J., Stage, J., Nielsen, L., & Hansen, K. S. "Creating and Using Personas in Software Development Practice". In International Journal of Advances in Software. Springer Berlin Heidelberg (2015).

This contribution examines the standing of Personas as a user-centred design technique in the industry and how Personas are perceived and utilised by practitioners. Previous studies have documented that software developers lack understanding of the end users and their needs (Bak, Nguyen, Risgaard, & Stage, 2008; Bruun & Stage, 2012). Personas have been described as a useful technique to address this deficit in understanding (A. Cooper & Reimann, 2003).

The data collection for this paper consisted of a questionnaire survey (Study A) and four qualitative interviews (Study B). Study A consisted of an online questionnaire survey administered to software development companies located in the geographical area of Northern Jutland in Denmark. The questionnaire was divided into two sections and consisted of both closed and open-ended questions. The first section gathered demographic data about the respondents and companies. Section 2 collected information about the respondent's knowledge about and usage of Personas, and a total of 60 people provided complete answers to the questionnaire. The closed questions were analysed quantitatively, and the open questions were analysed by using coding.

Study B consisted of four semi-structured interviews with software developers and project managers with varied experience in Personas usage. All interviews were conducted as semi-structured qualitative interviews, transcribed, and analysed using coding.

This contribution had three main findings. The first was that practitioners find Personas useful for keeping a continued focus on the end-users and their needs during the design and development process. Personas were described as particularly useful if there was no onsite customer to help developers keep the end users and their needs in mind.

The second finding is that the Personas technique, in general, was unknown to practitioners. The survey found that 45% of the respondents of the questionnaire had heard about the Personas technique, but only 23% had worked with Personas and 11.5% had used the Personas technique in their current job. The third finding was that there were four obstacles related to practitioners' use of Personas. First, managers, designers, and developers lacked knowledge about Personas. Secondly, projects did not have sufficient resources (time or funding) for conducting user research or user-centred de-

sign. Third, when Personas were created, they were generally short and sparse. Fourth, Personas were created only for use in the design phase.

This contribution helps to answer the second research question as it describes the knowledge and use of the user-centred design technique Personas in software development practices. This technique was found useful by practitioners to help maintain a focus on the end-users through the design and development process, but it is not widely known to practitioners. A lack of resources was one obstacle to implementing user-centred design in the industry. These findings correlate with the findings of Bak et al. (2008), who identified obstacles for conducting usability evaluations in the industry, including a lack of understanding of the method and techniques as well as insufficient resources.

3.3 Contribution 3

> Billestrup, J., Bruun, A. and Stage, J. "UX requirements to public systems for all: Formalisation or innovation." INTERACT 2015 Adjunct Proceedings: International Conference on Human-Computer Interaction. University of Bamberg Press, (2015).

In this contribution, the perceptions of how the user-centred materials developed by the joint IT organisation of the municipalities by the companies developing public self-service applications was examined. Additionally, it explored if these materials could assist the companies in conducting user-centred design in their development of public self-service applications.

This study was carried out with four companies developing self-service applications. The four companies were chosen based on the 11 interviews described in Contribution 1. Based on these interviews, a self-service area with four self-service providers was selected. The four companies varied in experience with developing this particular self-service application but also in regard to developing public self-service applications in general. The data was collected using three different methods. First, one half-day meeting was held with each of the four companies. Secondly, interviews were held with a total of 14 employees from the four companies. Third, a content analysis was conducted of documents gathered from both companies and the joint IT organisation of the municipalities.

The semi-structured qualitative interviews were conducted by phone, and all interviews were recorded for later transcription and analysis using coding. The collected documents were also analysed using coding. Both interviews and content analysis were done for the purpose of understanding how the user-centred materials were included in the design and development process of public self-service applications. Finally, a workshop was held with each of

the four companies in order to improve the user-centred materials developed by the joint IT organisation of the municipalities.

Like the previous contribution, this one had three main findings. First, the user-centred design materials designed by the joint IT organisation of the municipalities were focused on the front-end of the public self-service applications and the needs of the citizens. However, the companies designing and developing these public self-service applications are mainly focused on the back-end of the systems and the caseworkers, as the municipalities are the customers. This means that the needs of the citizens are only taken into account to the degree the caseworkers request and that the municipalities are willing to fund. Second, to make the user-centred design materials useful for companies and caseworkers, creation of such materials should include both citizens and caseworkers, taking both the front-end and back-end processes of the public self-service applications into account. Finally, to ensure the usability of the public self-service applications, it was suggested that usability evaluations of both the front-end and the back-end of the system should be mandatory.

This contribution helps to answer both the first and second research question regarding the development process of public self-service applications. The contribution found that the companies developing the public self-service applications are only focusing on the caseworkers and municipalities, but the user-centred materials from the joint IT organisation of the municipalities are only citizen-focused. It was suggested that usability evaluations should be mandatory as a quality indicator of a more user-centred approach to the design and development of both front-end and back-end processes.

3.4 Contribution 4

> Billestrup, J., Larusdottir, M., & Stage, J. "Four Public Self-Service Applications: A Study of the Development Process, User Involvement and Usability in Danish public self-service applications". International Journal of Advances in Software. (2016).

This contribution examines customer and user involvement in the design and development process and usability of public self-service applications developed by four companies. In this study, the user-centred design approach and user involvement are analysed and compared to the quality of each of the four public self-service applications. This study utilises the same data from Contribution 3, combined with a usability evaluation of the finished public self-service applications. The usability evaluations were conducted with

eight citizens in a usability laboratory using the think-aloud method (Rubin & Chisnell, 2008).

The data from the usability evaluations was analysed using instant data analysis (Kjeldskov, Skov, & Stage, 2004). The usability problems were categorised based on the levels of frustration and confusion of the test persons and whether the test persons were able to fill out the forms correctly, as described by Skov and Stage (2005).

This contribution had five main findings: First, the four companies either worked agilely or included agile elements in their development of public self-service applications. Caseworkers were involved as onsite customers, though the extent of their involvement varied.

Second, two of the developed public self-service applications had extensive usability problems, 36 and 37 respectively. In the other two, 17 and 29 problems were identified. Third, the two applications with the most customer involvement were more complex and contained more features, yet the most usability problems were identified in these same applications. Fourth, the more complex public self-service applications were developed with a greater focus on simplifying work processes for the caseworkers. Lastly, the interviewees desired more attention to applying a user-centred approach to the design and development of public self-service applications. However, two obstacles were described that prevented taking this more user-centred approach. First, the interviewees described being bound by existing design templates that were described as lacking usability. Second, the municipalities have very low budgets and are not willing to pay more than the bare minimum required, and taking a user-centred approach is perceived as being more expensive than a system-centred approach.

This contribution helps to answer both the first and the second research question as the paper explores the development process and provides an evaluation of the quality of the self-service applications. It was found that an entirely system-centred approach resulted in trivial public self-service applications that provided little or no value to caseworkers or citizens. A more user-centred approach with caseworker involvement resulted in complex public self-service applications, creating greater usability problems for the citizens. The restraints of existing design templates and the low budgets of the municipalities were identified as obstacles to utilising a more user-centred approach in the design and development of public self-service applications.

3.5 Contribution 5

> Billestrup, J., Stage, J. & Bruun, A. "The Usability State of Nine Public Self-Service Applications in Denmark". International Conference of Advances in Computer-Human Interaction. (2017).

The fifth contribution assessed the usability of nine public self-service applications to determine commonalities in the identified usability problems across these types of applications and the companies developing them. Previous studies have shown that whether citizens use public self-service applications recurringly depends on whether these applications are found easy to use (Clemmensen & Katre, 2012), as poor design can prevent citizens from routinely using these forms or websites (Wangpipatwong et al., 2008).

The data collected for this study was extracted from usability evaluations of nine public self-service applications in six self-service areas, developed by five companies. The usability evaluations of the nine public self-service applications were conducted between 2010 and 2016, and the six self-service areas were building permits (2010), assistive technologies and marriage certificates (both 2014), address change, rent subsidy, and changing medical practitioner (all 2016). All usability evaluations were conducted using the think-aloud method (Rubin & Chisnell, 2008) on a PC. The usability evaluations conducted in 2010 and 2014 were carried out in a usability laboratory with between four and ten citizens, and the evaluations from 2016 were conducted at a student café with six citizens.

The data from the usability evaluations was analysed using instant data analysis (Kjeldskov, Skov, Als, & Høegh, 2004). The usability problems were categorised based on frustration and confusion levels and whether the test persons were able to fill out the forms correctly (Skov & Stage, 2005). From the usability evaluations, lists of usability problems and categorisations were created. These lists were analysed using descriptive coding (Saldaña, 2015) of a total of 218 usability problems (21 critical, 100 serious, 93 cosmetic, and four uncategorised problems).

The results showed that three types of usability problems were recurring across the evaluated public self-service applications. First, test persons had problems understanding both the consequences of performing a particular action and the meaning of the technical terms used in the public self-service applications. Examples of this problem are test persons not understanding whether to click "yes" or "no", or not understanding what information they were supposed to enter in a text field. Second, test persons did not understand how to attach a file or could not determine if a file had been attached. For instance, test persons were not clicking "attach" after choosing the file they wanted to attach, meaning that the file was not attached. Test persons

also experienced problems seeing if a file had been attached, which resulted in test persons attaching the same file multiple times. Third, some test persons became stalled because they could not find the "next" button. Examples of this problem were the button being hidden until the test person scrolled down to the button of the page or the scrollbar at the side not being seen by all test persons.

This contribution helps to answer the first research question, as it identified usability problems across public self-service applications, self-service areas and companies. These problems indicate that the quality of these applications is low from the perspective of citizens. These types of usability problems meant that test persons had problems understanding what they were supposed to fill in or how to attach a file, along with problems moving through the steps of filling out the application as they had trouble locating the "next" button.

3.6 Contribution 6

> Billestrup, J., Bruun, A., & Stage, J. (2016). Usability Problems Experienced by Different Groups of Skilled Internet Users: Gender, Age, and Background. In International Conference on Human-Centred Software Engineering. Springer International Publishing.

This contribution examines whether skilled Internet users experience different types and number of usability problems based on gender, age, and educational background or job function. Previous studies have discussed the appropriate number of test persons and how to differentiate between the target user groups (Hwang & Salvendy, 2010; Law & Hvannberg, 2004; Lewis, 1994; Virzi, 1992). This study examines whether it is sufficient to represent the user group using test persons of both genders, different age groups and of different job functions or educational background. The data for this study was collected from a usability evaluation of a Danish data dissemination website (`www.dst.dk`) providing statistics about the Danish population. The study was conducted as a meta-analysis of usability problems extracted from a usability evaluation conducted with 41 test persons between the ages of 21 and 66 years old. The sample included students, faculty members and technical staff at a university, and 22 were female, 19 were male. On a Likert scale ranging from 1 to 5, 5 being the highest score, participants rated their level of skill using the Internet as either 4 or 5. Most test persons had either no or minimal experience using the chosen website. From the video analysis, a list of 147 usability problems had been developed. This list served as the basis for the meta-analysis. The analysis of the usability problems was conducted as closed coding. The problems were categorised according to

C. M. Nielsen, Overgaard, Pedersen, Stage, and Stenild (2006)'s 12 types of usability problems: affordance, cognitive load, consistency, ergonomics, feedback, information, interaction styles, mapping, navigation, task flow, user's mental model, and visibility. The coding and analysis were conducted by two evaluators and resulted in a list of 83 coded usability problems, as all problems for which the evaluators did not agree on the category were removed from the list. Of the twelve categories, usability problems were found in five categories: affordance, cognitive load, feedback, information, and visibility.

This contribution provides three main findings in relation to gender, age, job function and educational background. First, when dividing the found usability problems based on gender, no significant difference between the type or the number of usability problems was found. Second, test persons were divided into three age groups: below 27 years of age, 27-44 years, and over 44 years. No significant difference was found in the type or number of usability problems. Third, the test persons were sorted into categories based on their job function or educational background: computer science students, other students, computer science faculty, other faculty, and technical assisting personnel. Again, job function or educational background did not make a significant difference between the types or number of found usability problems.

This contribution helps to answer the second research question related to evaluating the quality of a software application when designing and developing for large heterogeneous user groups. The findings show no significant difference in the number of identified usability problems or the identified problem types when evaluating using test persons who are experienced Internet users.

Chapter 4

Research Methods

This chapter presents the research methods used for this PhD project to collect data for answering the research questions, including the strengths and weaknesses of each of the methods used. Table 4.1 presents an overview of the research methods applied to the individual contributions.

In the following sections, the methods and techniques used for collecting the data are described.

4.1 Case Study

A case study is an "in-depth study of a particular instance (or a small number of cases) within a specific real-life context" (Lazar, Feng, & Hochheiser, 2010). Conducting a case study allows the researcher to delve deeply into a particular area, which can either provide a deeper understanding of a known phenomenon or be used to develop new theories (Cavaye, 1996; Darke, Shanks, & Broadbent, 1998; Yin, 2003). Case studies also offer the option to conduct a study in a natural environment to learn about the current state of the art, and thereby generate theories from practice (Benbasat, Goldstein, & Mead, 1987).

Yin (2003) describes two types of case studies: single and multiple. In a single case study, one unique case is involved in the study (Yin, 2003). A multi-case study consists of two or more cases and one option is to consider it as multiple sets of single case studies (Yin, 2003). When conducting multiple case studies, the focus is on conducting replicative studies, and each case should be carefully chosen to either predict similar results or to predict contradictory results for predictable reasons (Yin, 2003).

In this thesis, both single and multiple case studies have been conducted as proposed by Yin (2003). Single case studies have been conducted for a unique case (Contribution 1), for testing and exploring a theory (Contribution

Contribution number and content	**Research Method**	**Techniques**
1. Analysis of the usability of the UCD materials in the development process and user involvement in the development of public self-service applications	• Single Case Study	• 11 semi-structured interviews • Coding: closed
2. Determining if and how the Personas technique is used in software development companies	• Survey • Single Case Study	• Questionnaire — 60 respondents • 4 semi-structured interviews • Coding: closed
3. Examining the use of and experiences with the user-centred materials and development approach of public self-service applications	• Multiple Case Study	• 14 semi-structured interviews • Content analysis • Coding: descriptive
4. Development process and user involvement in four companies, compared to the usability of public self-service applications	• Multiple Case Study • Usability Evaluations of Multiple Systems	• 14 semi-structured interviews • Content analysis • Coding: descriptive • Instant Data Analysis (IDA)
5. General usability problems across nine self-service applications, five self-service areas and six self-service providers	• Multiple Case Study • Usability Evaluations of Multiple Systems	• Instant Data Analysis (IDA) • Coding: descriptive
6. Usability problems experienced by 41 skilled IT users across gender, age, and educational background or job function	• Single Case Study • Usability Evaluations of Multiple Systems	• Video Analysis • Coding: closed

Table 4.1: Overview of the research methods applied to the individual contributions.

6), and for a representative case (Contribution 2). Multiple case studies have been conducted for Contributions 3, 4, and 5.

Conducting case studies has both advantages and disadvantages. The main advantages of this method are that case studies are recognised to be robust and reliable (Baxter & Jack, 2008) as well as contextual and versatile (Benbasat et al., 1987). A case study is considered to be both robust and reliable (Baxter & Jack, 2008), as conducting a case study can provide a comprehensive collection of data over a longer period of time. Multi-case studies are considered more robust than single case studies, but a single case study allows for study of a rare or critical case or testing of an existing theory (Yin, 2003). Case studies are considered particularly appropriate when research or theory is at an early formative stage or for practice-based problems because case-studies are contextually versatile as the methods and techniques for collecting the data can be adapted depending on the purpose of conducting each specific case study (Benbasat et al., 1987).

Reliability and validity can be improved by triangulation, combining several data collection methods from multiple sources as part of conducting a case study (Yin, 2003; Stake, 1995). For this thesis, triangulation was conducted by collecting data from multiple sources. This included conducting case study protocols and content analysis of key documents, interviews and meetings. Data gathered from each of the sources was then compared, such as comparing the information gathered from interviews with documents gathered from the company.

The main disadvantages of case studies are subjectivity (Darke et al., 1998) and poor generalisability (Abercrombie, Hill, & Turner, 1984; Lazar et al., 2010). Case studies can be subjective because of the intervention of the researcher as well as due to the data collection and analysis methods (Darke et al., 1998). The results of such studies can also be difficult to generalise because of their focus on a specific phenomenon, meaning that broad claims can be challenging to make based on a case study (Abercrombie et al., 1984; Lazar et al., 2010).

To lower the risk of subjectivity, fellow researchers were involved in reviewing the procedures and conclusions to increase the confidence in the conclusions, as proposed by Patton and Appelbaum (2003). This approach was applied to maintain awareness and openness to any contrary findings.

To enhance generalisation, each multiple-case study was conducted as multiple single-case studies where each step was replicated between the cases, and the developed theory was used to generalise the results of each case study to the theoretical propositions. Though the criticism of the lack of generalisability of case studies, Normann (1984) and Patton and Appelbaum (2003) emphasise that it is possible to generalise based on a few or even one single case study if the analysis is based on "a good descriptive or analytic language by means of which you can truly grasp the interaction between

various parts of a system and the important parts of a system" (Patton & Appelbaum, 2003).

4.2 Survey

Surveys can be defined as "a well-defined and well-written set of questions to which an individual is asked to respond" (Lazar et al., 2010). Here, the term survey refers to the methodology and incentives of the study, and questionnaire indicates the questions in the survey (Dillman, 2000). When designing a survey, the target responders and their interests and limitations need to be taken into consideration, and the questionnaire should be designed to reflect this understanding of the target responders (Lazar et al., 2010). Three main types of questions are used in a questionnaire (Dillman, 2000): open-ended questions with unrestricted answers; closed-ended questions using ordered response categories, such as Likert scales ranging from 1-10 to indicate the degree of agreement with a statement; and closed-ended questions with unordered response categories that provide a limited selection of response options.

For this thesis, a survey was conducted as part of the data collection for Contribution 2. The survey was developed as an online questionnaire and consisted of both open-ended questions, closed-ended questions with ordered responses, and closed-ended questions with unordered responses.

Survey studies have both strengths and limitations. The main advantages of conducting a survey are the ability to collect a large number of responses quickly, low costs, and the possibility of participants being geographically dispersed. In addition, surveys are a simple way to obtain a broad overview or snapshot of a user group (Lazar et al., 2010).

If a survey is well-constructed, the results will be robust and have high validity scores (Lazar et al., 2010). A survey is a useful technique to acquire data from a large user group that is geographically dispersed, as the questionnaire can be distributed through email or other platforms or media to the target user group. The data collection process itself is not very time-consuming for either the researcher or the respondents, meaning that data can be gathered relatively quickly. The questionnaire responses can be used to acquire an overall understanding of behaviour or a situation. A survey was conducted for Contribution 2, as the purpose was to determine if the Personas technique was known and used in the design and development process of software. Because of the advantages described above, the survey could be distributed to all known software development companies in the Danish region of Northern Jutland.

Despite the ease of surveys, they do carry some disadvantages. The information obtained is often limited and shallow, the question formulations

can lead to misunderstanding, and it is not possible to ask follow-up questions for clarification or deeper exploration of a topic (Lazar et al., 2010). As a survey only provides the big picture, it does not enable a deeper understanding of a phenomenon as follow-up questions are not possible, which limits the situations in which conducting a survey is useful. If a survey is not well-constructed or the questions not well-formulated and precise, misunderstandings and unusable responses can result. If an interesting phenomenon appears during the analysis, it is not possible to explore it by asking more detailed questions.

The research question was framed to take into account that the data would not be rich and would rather provide an overall picture of the knowledge and use of the Personas technique. The target user group was framed to only include software developing companies in the Danish region of Northern Jutland. This framing was designed to include software developing companies of all sizes in the study, with a realistic proportion of the different types and sizes of companies.

Before sending the questionnaire to respondents within the target group, the questionnaire was distributed to three fellow colleagues, and the questions were revised based on their feedback. This step was included to ensure the questions were not biased or could not be misinterpreted. The questionnaire was then distributed to two people within the target user group, and before distributing the questionnaire any further, their answers were evaluated to ensure they had understood the questions as was intended. As suggested by Lazar et al. (2010), the data was cleaned before conducting the analysis, meaning all responses were checked for being meaningful. The responses were divided into qualitative and quantitative responses before being analysed. The open-ended questions were coded and then analysed qualitatively, and the closed-ended questions with unordered response categories were analysed quantitatively.

4.3 Interviews

Interviews have been described as a method for acquiring a deep understanding of the interviewee and their subjective knowledge or opinions regarding a given problem (Kvale, 1997). Interviews can be conducted either as unstructured, which is opportunistic and flexible, or as a structured interview using a fixed interview guide, which is more strict, or a semi-structured interview which falls between the two (Kvale, 1997; Lazar et al., 2010). It is considered a strength that interviews provide an ability to "go deep" into a given subject (Lazar et al., 2010).

For this study, the theoretical framework for the qualitative research interview, described by Kvale, has been used (Kvale, 1997). The purpose of

conducting a qualitative semi-structured research interview is a gathering of descriptions of the interviewee's life and world in order to interpret the meaning of the described phenomena (Kvale, 1997).

Interviews are normally conducted face-to-face, but they can also be conducted by phone, VoIP (voice over Internet protocol) such as Skype or FaceTime, or by messages or email. Interviews can be conducted with one person at a time or as focus group interviews with two or more people.

For these studies, the interviews for Contribution 1 were conducted as phone interviews, and interviews for Contributions 2-4 were conducted as either phone or face-to-face interviews. Phone interviews were used in order to eliminate location as a possible obstacle. Such interviews do have a downside, as the dynamic of a phone interview is different than a face-to-face interview and lacks non-verbal cues, and the interviewees might be distracted by engaging in other activities while being interviewed (Lazar et al., 2010).

Conducting interviews has several advantages. Interviews offer the possibility of acquiring a deep understanding of the views, experiences and "life world" of the interviewees (Kvale, 1997; Lazar et al., 2010). They can also capture data that is otherwise challenging to obtain, enable exploration of an unknown topic, and are highly flexible (Lazar et al., 2010).

Interviews were conducted to acquire a deeper understanding of the development process of public self-service applications, as this data would otherwise be difficult to collect. The use of the semi-structured interview technique provided the framing of the questions as well as the flexibility to explore interesting topics during each interview.

At the same time, interviews have their own disadvantages. Interviewing is a skill that requires training and practice, and it can be difficult to manage the discussion to stay on topic (Lazar et al., 2010). The process of interviewing is time consuming, limiting the number of interviews that can be conducted (Lazar et al., 2010). In addition, the data collected is subjective and based on the recollection of the interviewees (Lazar et al., 2010).

Conducting interviews is challenging, both in regards to mastering the technique of asking questions in such a way as to elicit thorough answers from the interviewees but also in learning to manage the discussion, which requires practice (Lazar et al., 2010). The semi-structured interview was chosen for all interviews conducted for the contributions included in this thesis. The semi-structured form was chosen because this loose interview guide makes managing the discussion easier than when conducting an unstructured interview, while also making it possible to explore new topics during the interviews (Benyon, 2010).

The interviewees were allowed to continue speaking during the interviews in the spirit of keeping an exploratory mindset, although the resulting data collection was time-consuming. When the interviews were transcribed,

the sections that veered far from the topic were not transcribed, but a summary was written of the content. This meant that even if a topic was not initially transcribed, it could be transcribed later if the content was found to be relevant later during the analysis.

Though the subjectivity of interviews is seen as a disadvantage by authors such as Lazar et al. (2010), others like Kvale (1997) consider it the reason to conduct interviews. Kvale (1997) describes the purpose of interviews as a means to acquire this deep understanding of the interviewees and their subjective knowledge and opinions of a given problem. The purpose of conducting interviews as part of the data collection for the contributions used in this thesis was to gather rich information from the interviewees to understand their perspectives and experiences developing software. To counter the subjective nature of the interviews, either several individuals were interviewed from each company or the data from the interviews were triangulated with data collected by other means, as described in Section 4.1.

4.4 Usability Evaluation

Usability evaluations consist of representative users attempting to use a software system or product to solve representative tasks in representative environments (Lazar et al., 2010; Lewis, 2006). The purpose of the usability evaluation is to evaluate "the extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO9241, 1998). The goal is to improve the quality of the software or product by finding the flaws that cause problems for the users (Lazar et al., 2010).

Usability evaluations can be conducted on products such as software applications or mobile devices. They can occur during the design process using techniques such as paper prototyping or hi-fi prototyping, on finished software applications before release, or on already released software.

In this thesis, usability evaluations were conducted as part of the data collection for Contributions 4, 5, and 6 in order to test the quality of the software applications for citizens. All evaluated products were software applications for desktops, and all applications were either finished and about to be released or were already released.

Conducting a usability evaluation has several advantages. It is a well-established method rooted in classical experimental methodologies, and has been practised and researched for over 25 years, meaning that the techniques have been and continue to be improved to fit both research and practice. Usability evaluations provide an indicator of potential usability problems and how to resolve these (Rubin & Chisnell, 2008). In addition, doing an evaluation minimises the risk of releasing unusable software or applications

(Rubin & Chisnell, 2008), and doing a small evaluation is better than not doing one at all (Lazar et al., 2010).

Conducting a usability evaluation of software or an application can help identify potential usability problems and possible solutions to minimise the risk of releasing software or applications unusable by the target user group (Rubin & Chisnell, 2008). Usability evaluations can be conducted in many forms and using minimal resources and still have an impact (Lazar et al., 2010). This means that a usability evaluation does not need to involve 25 users to provide usable results. Virzi (1992) and J. Nielsen and Landauer (1993) have suggested that 4 to 5 testers are sufficient, and Law and Hvannberg (2004) stated 11 test persons were needed to find 80% of the usability problems, or 9 to 10 test persons to find 80% of the severe usability problems. In this thesis, usability evaluations were conducted to assess the usability of the developed public self-service applications.

Although usability evaluations can be beneficial, they have some disadvantages. An evaluation does not prove that the software or application works, only what does not work (Rubin & Chisnell, 2008).

A usability evaluation is conducted in a laboratory or the field, depending on available locations, the location of the test persons, or the data being collected (Lazar et al., 2010). It is well-known that the laboratory setting is artificial and can influence the test persons and their performance during the usability evaluation (Orne, 1962; Rubin & Chisnell, 2008; Johnson, 1998; Tamminen, Oulasvirta, Toiskallio, & Kankainen, 2004). Andreasen, Nielsen, Schrøder, and Stage (2007) referred to test-persons describing the laboratory set-up as more stressful than participating in remote synchronous usability evaluations. However, studies conducted in a usability laboratory have been shown to find more critical usability problems than remote asynchronous usability evaluations in which users are self-reporting usability problems (Andreasen et al., 2007; Bruun, Gull, Hofmeister, & Stage, 2009). Kjeldskov and Skov (2014) found no definite answer as to whether field evaluations should be better than the setting of a usability laboratory in regard to finding critical usability problems. There is no empirical evidence of other options being superior to a usability laboratory, in spite of the disadvantages of this setting.

As stated by Rubin and Chisnell (2008), a usability evaluation does not prove if a system works, but it does show what does not work in the system for the test-persons. This also makes it essential to represent the target user-group as closely as possible when conducting usability evaluations, which can be challenging for large heterogeneous user-groups (Rubin & Chisnell, 2008). For the usability evaluations conducted, the test persons varied in age, gender, educational background, IT skills and knowledge of the domain.

Chapter 5

Conclusion

In this chapter, the conclusions of this thesis are presented. The conclusions are provided by answering the research questions, the limitations in the research process, and suggestions for future work.

5.1 Research Question 1

My first research question was:

> To what extent do companies developing public self-service applications employ a system-centred approach and how does that affect the quality of the systems for the citizens?

To answer this research question, studies were conducted for Contributions 1, 3, 4, and 5. These papers focus on analysing the current process of developing public self-service applications as well as assessing the usability of these applications. Additionally, the extent to which companies are developing public self-service applications by employing a system-centred approach has been documented by Contributions, 1, 3, and 4.

In Contribution 1, the interviews demonstrated that eight out of 11 companies primarily use an agile development approach, which includes short iterations, sprints and an onsite customer. The remaining three companies used a combination of an agile development method and a staged development method like the waterfall method, depending on the project and the customer. Contribution 1 also showed that although the developed public self-service applications have two user groups, citizens, and caseworkers, only caseworkers were involved in the design and development process. The involvement of the caseworkers was limited to acquiring an understanding of the work processes, technical aspects, and features of these applications. Citizens were described as lacking the motivation more than the ability to

use the public self-service applications, and problems experienced by the citizens was reported by the caseworkers to the companies after the release. The problems would then be fixed with a patch if they were determined to be easily repaired.

In Contribution 3, it was found that the companies designing and developing the public self-service applications mainly focus on the back-end of the systems and the caseworkers. The municipalities are described as the customers, meaning that the needs of the citizens only become a priority if required and funded by the municipalities.

In Contribution 4, it was found that the degree and type of caseworker involvement varied, as did the focus of the public self-service applications developed, based on this involvement. The contribution showed that the companies frequently involved caseworkers focused more on simplifying work processes and thereby easing the workload of the caseworkers. The public self-service applications developed with the most caseworker involvement contained more technical features focused on simplifying the work processes of the caseworkers.

In conclusion, the companies used a system-centred approach when developing public self-service applications. The involvement of the caseworkers and the focus on technical aspects and features correlate with Cockton's view of system-centred design, as this approach means that the features are considered independently of the citizens and their use situation (Cockton, 2004). The citizens are seen as lacking the motivation to resolve their problems in using public self-service applications themselves. Some issues are fixed after the release based on reports from the caseworkers, but the focus of these fixes correlates with the views of Wasserman (1973) of "idiot-proofing" the system.

The quality of the public self-service applications from a citizen perspective when using a system-centred approach has been documented by Contributions 4 and 5. These papers focus on how the companies developing public self-service applications ensure that they are usable for the citizens.

Contribution 4 found that ensuring quality for the citizens was not a priority, and the usability evaluations showed that the usability of the public self-service applications is low. Ordering a hearing aid should be a relatively simple procedure, but the usability evaluations showed it was challenging for citizens to fill out the public self-service applications correctly.

Instead, the companies were focusing on easing the workload of the caseworkers by adding flexibility for caseworkers to add or remove features or change the wording of the public self-service applications, along with simplifying work processes via steps such as replacing decisions made by caseworkers with instantaneous decisions that did not require caseworker involvement.

Along similar lines, Contribution 5 described how different groups of citizens experienced similar usability problems with nine different public self-service applications. The usability evaluation establishes if specified users can achieve specified goals with effectiveness, efficiency and satisfaction in a specified use context (ISO9241, 1998). Applied to public self-service applications, this means that the quality of the application depends on whether citizens can complete the applications easily, correctly, and efficiently. Contribution 5 found a general lack of quality as similar usability problems were found when different groups of citizens evaluated nine public self-service applications, especially in regard to the three areas of meaning of concepts, attachment of files, and button placement.

In conclusion, Contributions 4 and 5 have shown that the quality of the public self-service applications is low from the citizens' perspective which is in alignment with that citizens has not been made a priority and citizens have not been involved in the design and development process, as the main focus of the companies has been to create value for the caseworkers. However, for caseworkers to fully receive this value, the citizens need to be able to fill out these applications correctly, which these contributions have shown not to be the case at present.

5.2 Research Question 2

My second research question was:

> To what extent can companies developing public self-service applications employ a user-centred approach in the development process and how does that affect the quality of the systems for the citizens?

To answer this research question, studies for Contributions 2, 3, 4, and 6 were conducted. These papers analyse the process of employing a user-centred approach to develop public self-service applications, assessing the usability and thereby the quality of these applications. Three of the contributions, 2, 3, and 4, explore the extent to which companies can employ a user-centred approach in the development process.

Contribution 2 focuses on the user-centred design technique known as Personas. Practitioners knowledgeable about Personas perceived the technique as useful to maintain focus on the end users through the design and development process. Personas have been described as a strong tool for targeting large heterogeneous user segments, where involving a few users might not be sufficient (Cooper, 1999; Nielsen, 2004), which makes the Personas technique particularly relevant when designing and developing public self-service applications. Yet Personas is not widely known by practitioners.

Besides a lack of knowledge of Personas, practitioners also lacked resources for conducting user research or user-centred design in general. This lack of resources to conduct user-centred design also offer an explanation of when the Personas technique was used, it was mainly applied in the design phase and done sparsely and briefly to keep the cost low.

In Contribution 3, it was apparent that the user-centred design materials developed by the joint IT organisation of the municipalities are focused on the citizens, but the companies are focusing on the caseworkers when designing and developing the public self-service applications. To ensure that the companies focus on usability for the citizens, and thereby the quality, usability evaluations of both front-end and back-end of all new public self-service applications should be mandatory. According to the interviewees from the companies, this approach could ensure a more user-centred approach to the design and development of public self-service applications. However, Tarkkanen and Harkke (2015) conclude that mandatory usability evaluations will lead to usability workarounds by the companies designing and developing these public self-service applications, as the companies then tend to focus more on the user performance than on the usability. To avoid these usability workarounds Tarkkanen and Harkke (2015) suggest avoiding rigid criteria such as detailed usability requirements, and use open-ended usability test tasks instead.

Additionally, Contribution 4 showed that companies developing public self-service applications wanted to apply a more user-centred approach, but the interviewees were limited by two obstacles. First, designers were bound by an existing design template, which the interviewees described as low in usability, and they were prohibited from making any changes to the template. Second, public self-service applications designed and developed by involving citizens and user-centred design techniques are expected to cost more as it would lengthen the process. The interviewees stated this would not be profitable as the municipalities expect to pay the bare minimum when buying public self-service applications from the companies. However, these expectations from the interviewees do not correspond with the findings of Boehm et al. (1984) showing that using the user-centred design technique prototyping instead of a system-centred approach resulted in products of equal performance with less effort and less code.

In conclusion, the companies lack knowledge about user-centred design techniques such as Personas. There is a perception that using a more user-centred approach would not be profitable for the companies, but the validity of this statement is questionable. It was also stated by the interviewees that mandatory usability evaluations of all public self-service applications would result in a more user-centred approach during the design and development process of the public self-service applications. Whether mandatory usability evaluations will function as expected depends on the implementation and

rigidity of the criteria used for conducting the usability evaluations. Otherwise, companies may begin focusing on "passing" the usability evaluation instead of designing and developing the public self-service application through a user-centred approach focusing on the usability.

The quality of the public self-service applications from a citizen perspective when employing user-centred design was not addressed by any of my contributions. However, Contribution 6 and part of Contribution 4 provide some clues.

For example, Contribution 4 found that no citizens were involved in the design and development of the public self-service applications, and little attention was given to applying a user-centred design approach to ensure quality for the citizens. In contrast, the caseworkers were involved. The purpose of this involvement was to provide quality for the caseworkers by simplifying work-processes and easing their workload. This lead to the implementation of instantaneous decisions which create value for the caseworkers as they save time not having to process simple applications. As the involvement of the caseworkers has created value for the caseworkers, it may be assumed that involving citizens in the design and development process would create value for the citizens. However, this hypothesis cannot be confirmed by the findings of this thesis.

In Contribution 6, which conducted a usability evaluation with experienced Internet users, no significant difference was found in either number or type of usability problems across gender, age, job function or educational background. The user group of public self-service applications includes all Danish citizens and is a large and heterogeneous user group. This contribution shows that for experienced Internet users, dividing participants into groups by gender, age, educational background and job function seems unnecessary when determining the usability of public self-service applications. This finding correlates with Caulton (2001), as it was suggested that skill level could be a sufficient way to divide user groups when the usability and quality of the software for a large heterogeneous user group is evaluated. This indicates a lower number of required test persons is sufficient for conducting usability evaluations of public self-service applications. If these indications are correct, it will be lowering the costs of conducting a usability evaluation and thereby eliminating a significant obstacle for employing a more user-centred approach in the development of such systems.

Thus, although Contributions 4 and 6 do not provide definite answers to the research question, some indications are offered. Public self-service applications should be designed and developed with a focus on the quality for both citizens and caseworkers. It has been shown that even minor involvement of the caseworkers during the design and development process means that the developed public self-service applications become more focused on

creating value for them. As a minor involvement of caseworkers can lead to an increased quality of the back-end of the public self-service applications, it seems plausible that involving citizens would have a similar effect on the front-end. Conducting a usability evaluation of a public self-service application to assess the quality could be less costly than expected, at least for the user group of skilled Internet users.

5.3 General Research Question

My general research question was:

> To what extent can companies developing public self-service applications benefit from combining a system-centred and a user-centred approach and how does that affect the quality of the systems?

This thesis has examined how companies are developing public self-service applications and the involvement of end users in the design and development process. It has been shown that companies primarily employ a system-centred approach focusing on the technical quality of the public self-service applications, resulting in applications that are functional from a technical point of view and possess fundamental technical qualities. None of the findings of this thesis contradicts that companies and municipalities would benefit from combining a system-centred and user-centred approach.

Part of the motivation for the digitalisation of public self-service applications was to reduce administrative costs. In 2016, the National Audit Office in Denmark produced a report on the current savings of the digitalisation process (Rigsrevisionen, 2016). This report showed that the digitalisation of mail sent from government agencies to citizens and companies has only produced 20% of the estimated savings. These savings came directly from not paying postage. The expected reduction in payroll costs has not been achieved.

In November 2017, the head of IT and the digitalisation strategy in the municipality of Herning stated that the public self-service applications still lack usability (Den offentlige, 2017). The strategy for digitalisation in Herning from 2017 to 2020 is to include citizens in the process to increase usability and create value for the citizens (Den offentlige, 2017). This approach from the municipality of Herning corresponds with the findings of this thesis. Public self-service applications lack usability for the citizens and part of the solution is to involve citizens in the design and development process. Usable public self-service applications can also decrease the time caseworkers spend processing these applications since they would not need to spend time obtaining the correct information from the citizens (Bruun & Stage, 2014).

This decrease of time consumption means that developing public self-service applications developed with the involvement of all types of stakeholders and focused on usability could be part of the solution for recouping the estimated savings from the digitalisation process of public self-service applications.

The caseworkers have been involved in the design and development process but only to limited degrees, and mainly to provide knowledge and feedback on needed features, both for the front-end and the back-end of the public self-service applications. The companies have been collaborating with the caseworkers to develop systems focused on features wanted by the caseworkers, but citizens have been neither involved or in focus in either the design or development process.

Several obstacles have to be overcome before it is plausible to combine the currently practised system-centred approach with a user-centred approach where all main stakeholders are included in the design and development process of public self-service applications. Municipalities lack resources and put pressure on the companies developing public self-service applications to keep the cost low. A user-centred focus has been found to reduce the effort and amount of code without lowering the quality (B. Boehm, Gray, & Seewaldt, 1984) which means that a user-centred focus could reduce the development costs. However, this is the opposite of what was stated by the interviewees, indicating that the mindset of the interviewees is also an obstacle of conducting user-centred design, which corresponds to the findings by Bak et al. (2008) and Svanæs and Gulliksen (2008) stating that the mindset of the developers, as well as the mindset of both developer and customer organisations, is an obstacle to conducting user-centred design.

The companies developing public self-service applications have primarily used agile development or agile elements of the design and development process. In agile development, customers and users are often seen as the same user-group, which is not always the case (Armitage, 2004; Blomkvist, 2005; Hudson, 2003). In the area of public self-service applications, the customers are the municipalities, and the users are the caseworkers using the back-end systems and the citizens using the front-end systems. Beck (2000) states that the ideal customer to include in the agile development process is a customer who is also a user of the system. The main obstacles for combining user-centred design with an agile development method are that user involvement becomes more complicated when working with different groups of stakeholders. The agile philosophy itself does not reflect the necessary focus on users and usability and therefore does not support for designing and developing software by a user-centred focus (Blomkvist, 2005).

The idea that caseworkers can represent all stakeholders is too simplified, and it is unrealistic that a single person can represent all stakeholders in the development of public self-service applications. To employ a user-centred

approach, all main stakeholders have to be involved. Involving caseworkers could keep the system-centred focus, but including citizens would mean that this focus can be combined with a user-centred approach that could lead to public self-service applications of higher quality from both a system-centred and a user-centred point of view. Such a combination would maintain the focus on developing functional, technical applications, which would also provide value for both caseworkers and citizens.

5.4 Limitations of the Research

This thesis is based on the research methods, case studies, interviews, a questionnaire survey, and usability evaluations. These methods have strengths and weaknesses as discussed in Chapter 4 and though countermeasures to overcome these issues have been taken, the thesis still has some limitations.

The case-studies include both single and multi-case studies. These involved companies, citizens, and the joint IT organisation of the municipalities which have provided different perspectives on the design and development process, and the quality of public self-service applications. However, a limitation of the case studies is that all stakeholders were not involved since the caseworkers for the municipalities were not part of this study.

The case-studies were also limited to one area of the public self-service applications, which is a potential limitation to generalising the results. However, the usability evaluations of nine other public self-service applications showed similar usability problems across the usability evaluated public self-service applications.

Though a significant number of interviews were conducted for these studies, the interviews were short and focused on an overall level. It is a potential limitation that the interviews did not acquire a deeper understanding of the development approach and processes of the companies developing public self-service applications.

The questionnaire survey was distributed in a limited geographical area. It had an acceptable response rate. Distributing the questionnaire survey in a defined geographical area provides a complete picture of the knowledge of the companies located in that area, but it also makes it unclear if the results are generalisable to a wider geographical area. The companies answering the questionnaire survey were distributed between large, medium, and small-sized companies but they might not have been representative of all software developing companies in the region of Northern Jutland.

Usability evaluations were conducted for some public self-service applications which makes it unclear if the results are generalisable across all public self-service applications. The number of test persons used in some of the usability evaluations was also limited but corresponds to the tradition of the

research community.

5.5 Future Work

The public self-service applications included in the studies conducted for this thesis have exhibited that the technical quality of such applications appears to be reasonable. However, media in Denmark have reported about technical deficiencies, such as security problems related to public self-service applications (Finans, 2017; Version 2, 2017b). It would be interesting to conduct a study more focused on the technical quality of the public self-service applications.

Contribution 5 reported the results of a study conducted with experienced Internet users that found no significant difference in the types or numbers of usability problems when participants were divided into groups based on gender, age, job function or educational background. It would be helpful to expand this study to include participants with more limited Internet skills to determine if the results are generalisable across various skill levels.

This study summarises the results of current development practices and the quality of the end-products for citizens when applying a system-centred approach in the development of public self-service applications. There is a gap in available results on the quality of public self-service applications from the citizens' perspective when these applications have been developed by combining a system-centred approach with a user-centred approach. Although establishing a direct link between user-centred design and the quality of the developed application is not straightforward, future research should focus on studying the design and development process of a combined system-centred and user-centred approach and its impact on the quality of the public self-service applications.

References

Abbott, L. (1956). Quality and competition: an essay in economic theory.

Abercrombie, N., Hill, S., & Turner, B. S. (1984). *Dictionary of sociology*. Penguin Books.

Abras, C., Maloney-Krichmar, D., & Preece, J. (2004). User-centered design. *Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications*, *37*(4), 445–456.

Alexander, C. (1964). *Notes on the synthesis of form* (Vol. 5). Harvard University Press.

Andreasen, M. S., Nielsen, H. V., Schrøder, S. O., & Stage, J. (2007). What happened to remote usability testing? An empirical study of three methods. In *Proceedings of the sigchi conference on human factors in computing systems* (pp. 1405–1414).

Armitage, J. (2004). Are agile methods good for design? *Interactions*, *11*(1), 14–23.

Bak, J. O., Nguyen, K., Risgaard, P., & Stage, J. (2008). Obstacles to usability evaluation in practice: a survey of software development organizations. In *Proceedings of the 5th Nordic conference on Human-Computer Interaction* (pp. 23–32). doi: 10.1145/1463160.1463164

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report*, *13*(4), 544–559.

Beck, K. (2000). *Extreme programming explained: embrace change*. Addison-Wesley Professional.

Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS quarterly*, 369–386.

Benyon, D. (2010). *Designing interactive systems: a comprehensive guide to HCI and interaction design.* Addison-Wesley.

Bevan, N. (1995). Usability is quality of use. *Advances in Human Factors/Ergonomics*, *20*, 349–354.

Bevan, N. (1999). Quality in use: Meeting user needs for quality. *Journal of systems and software*, *49*(1), 89–96.

Blomkvist, S. (2005). Towards a model for bridging agile development and user-centered design. *Human-centered software engineering—integrating usability in the software development lifecycle*, 219–244.

Bødker, S., & Grønbæk, K. (1991). Cooperative prototyping: users and designers in mutual activity. *International Journal of Man-Machine Studies*, *34*(3), 453–478.

Boehm, B., Gray, T., & Seewaldt, T. (1984). Prototyping vs. specification: A multi-project experiment. In *Seventh conference on software engineering* (pp. 473–484). IEEE.

Boehm, B. W., Brown, J. R., & Kaspar, H. (1978). Characteristics of software quality.

Bostrom, R. P., & Heinen, J. S. (1977). MIS problems and failures: a socio-technical perspective, part ii: the application of socio-technical theory. *MIS quarterly*, 11–28.

Broh, R. A. (1982). *Managing quality for higher profits: A guide for business executives and quality managers*. McGraw-Hill.

Bruun, A., Gull, P., Hofmeister, L., & Stage, J. (2009). Let your users do the testing: A comparison of three remote asynchronous usability testing methods. In *Proceedings of the sigchi conference on human factors in computing systems* (pp. 1619–1628).

Bruun, A., & Stage, J. (2012). Training software development practitioners in usability testing: an assessment acceptance and prioritization. In *Proceedings of the 24th Australian Computer-Human Interaction Conference* (pp. 52–60). doi: 10.1145/2414536.2414545

Bødker, S., Grønbæk, K., Bannon, L., & Grudin, J. (1993). Achieving cooperative system design. In D. Schuler & A. Namioka (Eds.), *Participatory design: principles and practices* (pp. 79–98). Lawrence Erlbaum Associates, Inc.

Carroll, J. M. (1996). Encountering others: Reciprocal openings in participatory design and user-centered design. *Human–Computer Interaction*, *11*(3), 285–290.

Caulton, D. A. (2001). Relaxing the homogeneity assumption in usability testing. *Behaviour & Information Technology*, *20*(1), 1–7.

Cavaye, A. L. (1996). Case study research: a multi-faceted research approach for is. *Information systems journal*, *6*(3), 227–242.

Clemmensen, T., & Katre, D. (2012). Adapting e-gov usability evaluation to cultural contexts. In *Usability in government systems* (pp. 331–344). Elsevier.

Cockton, G. (2004). From quality in use to value in the world. In *Chi'04 extended abstracts on human factors in computing systems* (pp. 1287–1290).

Cockton, G. (2005). A development framework for value-centred design. In *Chi'05 extended abstracts on human factors in computing systems* (pp. 1292–1295).

Computerworld. (2008). `https://www.computerworld.dk/art/49228/kmd-salg-farvel-til-kommunedata-uden-fest`. (Last accessed October, 2017)

Cooper, A., & Reimann, R. (2003). *About face 2.0: the essentials of interaction design.* Wiley, Indianapolis.

Cooper, R. G. (1999). The invisible success factors in product innovation. *Journal of product innovation management*, *16*(2), 115–133.

Crosby, P. B. (1979). *Quality is free*. McGraw-Hill.

Dansk Industri. (2016). `https://di.dk/SiteCollectionDocuments/Digitaliseringsindsatsen/16062016%20Hvad%20ved%20vi%20om%20digitalisering%20i%20andre%20lande%20(4%200).pdf`. (Last accessed October 2017)

Darke, P., Shanks, G., & Broadbent, M. (1998). Successfully completing case study research: combining rigour, relevance and pragmatism. *Information systems journal*, *8*(4), 273–289.

Das, A., & Svanæs, D. (2013). Human-centred methods in the design of an e-health solution for patients undergoing weight loss treatment. *International Journal of Medical Informatics*, *82*(11), 1075–1091.

Den offentlige. (2017). `http://denoffentlige.dk/poul-venoe-selvbetjeningsloesninger-skal-vaere-mere-brugervenlige`. (Last accessed December, 2017)

Dillman, D. (2000). *Mail and internet surveys: The tailored design method*. John Wiley & Sons.

Dillon, A., Sweeney, M., & Maguire, M. (1993). A survey of usability engineering within the european it industry-current practice and needs. In *Proceedings of HCI* (pp. 81–94).

Dromey, R. G. (1995). A model for software product quality. *IEEE Transactions on Software Engineering*, *21*(2), 146–162.

E-Boks. (2017). *E-boks.* `https://www.e-boks.com/danmark/da/hvad-er-e-boks/`. (Last accessed October 2017)

Ehn, P. (1993). Scandinavian design: On participation and skill. *Participatory design: Principles and practices*, 41–77.

Ehn, P. (2008). Participation in design things. In *Proceedings of the tenth anniversary conference on participatory design 2008* (pp. 92–101).

Ehn, P., & Kyng, M. (1987). The collective resource approach to systems design. *Computers and Democracy — a Scandinavian Challenge*, 17–57.

Ehn, P., & Sandberg, Å. (1983). Local union influence on technology and work organization — some results from the demos project. *U. Briefs*, 427–437.

Elkjær, M. (2011). *Ekspert: Sådan får vi succes med selvbetjening.* `https://www.computerworld.dk/art/116061/ekspert-saadan-faar-vi-succes-med-selvbetjening`. (Last accessed April 2017)

Eriksson, E. (2013). *Situated reflexive change: User-centred design in (to) practice* (PhD Thesis). KTH Royal Institute of Technology.

European Commission. (2016). *DESI Index.* `https://ec.europa.eu/digital-agenda/en/scoreboard/`. (Last accessed 08-01-2018)

European Commission. (2017). *The digital economy and society index (desi).* `https://ec.europa.eu/digital-single-market/en/desi`. (Last accessed April 2017)

Feigenbaum, A. V. (1961). *Total quality control: engineering and management, the technical and managerial field for improving product quality, including its reliability, and for reducing operating cost and losses.* McGraw-Hill.

FFSO. (2014). `http://www.ffso.dk/index.php/10-fra-guldborgsund/23-borgerservice-lukkes`. (Last accessed April 2017)

Finans. (2017). *KMD: Vores system er hullet — men Esben Warming er stadig en hacker.* `http://finans.dk/erhverv/ECE9655720/kmd-vores-system-er-hullet-men-esben-warming-er-stadig-en-hacker/?ctxref=ext`. (Last accessed August 2017)

Gärtner, J. (1998). Participatory design in consulting. *Computer Supported Cooperative Work (CSCW)*, *7*(3-4), 273–289.

Garvin, D. A. (1984). What Does "Product Quality" Really Mean? *Sloan management review*, 25.

Gilmore, H. L. (1974). Product conformance cost. *Quality progress*, *7*(5), 16–19.

GOV.UK. (2012). *UK Design Principles.* `https://www.gov.uk/design-principles`. (Last accessed March 2017)

Greenbaum, J. M., & Kyng, M. (1991). *Design at work: Cooperative design of computer systems*. L. Erlbaum Associates Inc.

Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J., & Cajander, Å. (2003). Key principles for user-centred systems design. *Behaviour and Information Technology*, *22*(6), 397–409.

Hartson, H. R., & Hix, D. (1989). Human-computer interface development: concepts and systems for its management. *ACM Computing Surveys (CSUR)*, *21*(1), 5–92.

Hekkert, P., & van Dijk, M. (2001). Designing from context: Foundations and applications of the vip approach. In *Designing in context: Proceedings of design thinking research symposium* (Vol. 5, pp. 383–394).

Huang, Z., & Benyoucef, M. (2014). Usability and credibility of e-government websites. *Government Information Quarterly*, *31*(4), 584–595.

Hudson, W. (2003). Adopting user-centered design within an agile process: A conversation. *Cutter IT Journal*, *16*(10), 5–12.

Hwang, W., & Salvendy, G. (2010). Number of people required for usability evaluation: the 10±2 rule. *Communications of the ACM*, *53*(5), 130–133.

Iivari, J., & Iivari, N. (2011). Varieties of user-centredness: An analysis of four systems development methods. *Information Systems Journal*, *21*(2), 125–153.

Iivari, N. (2004). Enculturation of user involvement in software development organizations-an interpretive case study in the product development context. In *Proceedings of the third Nordic conference on Human-Computer Interaction* (pp. 287–296).

ISO8402. (1994). *Iso 8402: 1994: Quality management and quality assurance — vocabulary*. International Organization for Standardization.

ISO9241. (1998). *Iso 9241-11. ergonomic requirements for office work with visual display terminals (vdts) — part 11: guidance on usability.*

Johnson, P. (1998). Usability and mobility; interactions on the move. In *Proceedings of the first workshop on human-computer interaction with mobile devices.*

Karat, J. (1997). Evolving the scope of user-centered design. *Communications of the ACM*, *40*(7), 33–38.

Keen, P. G. W., & Scott, M. (1978). *Decision support systems; an organizational perspective* (Tech. Rep.).

Kensing, F., & Blomberg, J. (1998). Participatory design: Issues and concerns. *Computer Supported Cooperative Work (CSCW)*, *7*(3-4), 167–185.

Kensing, F., & Munk-Madsen, A. (1993). PD: Structure in the Toolbox. *Communications of the ACM*, *36*(6), 78–85.

Kensing, F., Simonsen, J., & Bødker, K. (1998). Participatory design at a radio station. *Computer Supported Cooperative Work (CSCW)*, *7*(3), 243–271.

Kjeldskov, J., & Skov, M. B. (2014). Was it worth the hassle? ten years of mobile hci research discussions on lab and field evaluations. In *Proceedings of the 16th international conference on human-computer interaction with mobile devices & services* (pp. 43–52). ACM.

Kjeldskov, J., Skov, M. B., Als, B. S., & Høegh, R. T. (2004). Is it worth the hassle? exploring the added value of evaluating the usability of context-aware mobile systems in the field. In *International conference on mobile human-computer interaction* (pp. 61–73).

Kjeldskov, J., Skov, M. B., & Stage, J. (2004). Instant data analysis: conducting usability evaluations in a day. In *Proceedings of the third Nordic conference on Human-Computer Interaction* (pp. 233–240).

Klein, H., & Alvarez, R. (1985). Information systems in the hotel industry: Part of a problem or part of a solution? In *Proceedings of the working conference on development and use of computer-based systems and tools in the context of democratization of work, aarhus, denmark.*

Kombit. (2011). *Effektiv & innovativ digitalisering af den kommunale sektor 2011-2015 — handlingsplan for den fælleskommunale digitaliseringsstrategi 2011-2015.* `https://www.kombit.dk/sites/default/files/user_upload/documents/Digistrategi_2011-2015/Handlingsplan%20for%20digistrategien%202011-2015.pdf`. (Last accessed April 2017)

Kombit. (2014, December). *User journey.* `http://www.kl.dk/ImageVaultFiles/id_60480/cf_202/Illu.PDF`. (Last accessed November 2016)

Kommunernes Landsforening. (2012a, December). *Stage plan.* http://www.kl.dk/Om-KL/Opdateret-version-af-bolgeplanen-for-obligatorisk-digital-selvbetjening-id114939/?n=0&section=4652. (Last accessed 07-01-2018)

Kommunernes Landsforening. (2012b, June). http://www.kl.dk/Administration-og-digitalisering/Lov-om-obligatorisk-digital-selvbetjening-og-digital-post-er-vedtaget-id105354/. (Last accessed 07-01-2018)

Korpela, M., Soriyan, H. A., Olufokunbi, K., Onayade, A., Davies-Adetugbo, A., & Adesanmi, D. (1998). Community participation in health informatics in africa: An experiment in tripartite partnership in ile-ife, nigeria. *Computer Supported Cooperative Work (CSCW)*, *7*(3-4), 339–358.

Kujala, S. (2003). User involvement: a review of the benefits and challenges. *Behaviour & information technology*, *22*(1), 1–16.

Kvale, S. (1997). *Interview. 7. oplag*. Hans Reitzels Forlag.

Kyng, M. (1996). Users and computers-a contextual approach to design of computer artifacts. *DAIMI Report Series*, *25*(507).

Kyng, M., & Mathiassen, L. (1982). Systems development and trade union activities. *Information society, for richer, for poorer*, 247–260.

Law, E. L.-C., & Hvannberg, E. T. (2004). Analysis of combinatorial user effect in international usability tests. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 9–16).

Lazar, J., Feng, J. H., & Hochheiser, H. (2010). *Research methods in human-computer interaction*. John Wiley & Sons.

Lewis, J. R. (1994). Sample sizes for usability studies: Additional considerations. *Human factors*, *36*(2), 368–378.

Lewis, J. R. (2006). Usability testing. *Handbook of human factors and ergonomics*, *12*.

Macleod, M. (1994). Usability in context: Improving quality of use. In *Proceedings of the International Ergonomics Association 4th International Symposium on Human Factors in Organizational Design and Management.*

Mayhew, D. J. (1999). *The usability engineering lifecycle: A practitioner's handbook for user interface design*.

McCall, J. A., Richards, P. K., & Walters, G. F. (1977). *Factors in software quality. volume i. concepts and definitions of software quality* (Tech. Rep.). General Electric.

McKinsey. (2014). https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/public-sector-digitization-the-trillion-dollar-challenge. (Last accessed October 2017)

Molich, R. (2014). *Brugervenlighed i offentlige selvbetjeningsløsninger i bølge 2.* (White paper)

Moon, M. J. (2002). The evolution of e-government among municipalities: rhetoric or reality? *Public administration review*, *62*(4), 424–433.

Mumford, E. (1983). *Designing secretaries: The participative design of a word processing system*. Manchester Business School Manchester.

Mumford, E. (1985). Sociotechnical systems design: Evolving theory and practice.

Nielsen, C., Stage, J., Bruun, A., & Pedersen, O. (2010). *Brugervenlig net-selvbetjening kan give kæmpe besparelse.* http://www.nyhedsarkiv.aau.dk/2010/nyhed/brugervenlig-net-selvbetjening-kan-give-kaempe-besparelse.cid260279. (Last accessed April 2017)

Nielsen, C. M., Overgaard, M., Pedersen, M. B., Stage, J., & Stenild, S. (2006). It's worth the hassle!: The added value of evaluating the usability of mobile systems in the field. In *Proceedings of the 4th Nordic conference on Human-Computer Interaction* (pp. 272–280).

Nielsen, J. (1994a). *Usability engineering*. Elsevier.

Nielsen, J. (1994b). Usability laboratories. *Behaviour & Information Technology*, *13*(1-2), 3–8.

Nielsen, J. (1995). *10 usability heuristics for user interface design.*

Nielsen, J., & Landauer, T. K. (1993). A mathematical model of the finding of usability problems. In *Proceedings of the INTERACT'93 and CHI'93 conference on Human factors in computing systems* (pp. 206–213).

Normann, R. (1984). *Service management*. JSTOR.

Nygaard, K. (1979). The "Iron and Metal Project": Trade Union Participation. *Computers Dividing Man and Work*, 94-107.

Nygaard, K., & Bergo, O. T. (1975). The trade unions-new users of research. *Personnel review*, *4*(2), 5–10.

Oostveen, A.-M., & van den Besselaar, P. (2005). User Involvement in Large-Scale eGovernment Projects: Finding an Effective Combination of Strategies and Methods. In *Proceedings of the INTERACT 2005 workshop on User Involvement in e-Government development projects.*

Oppermann, R. (2005). User participation supported by usability engineering experts in e-Government projects2. In *Proceedings of the INTERACT 2005 workshop on User Involvement in e-Government development projects* (p. 19).

Orne, M. T. (1962). On the social psychology of the psychological experiment: With particular reference to demand characteristics and their implications. *American psychologist*, *17*(11), 776.

Patton, E., & Appelbaum, S. H. (2003). The case for case studies in management research. *Management Research News*, *26*(5), 60–71.

Pfleeger, S., & Kitchenham, B. (1996). Software quality: The elusive target. *IEEE Software*, *13*(1), 12–21.

Politiken. (2013). *Selv et simpelt lægeskift er rent kaos.* `http://politiken.dk/debat/kroniken/art5462195/Selv-et-simpelt-l%C3%A6geskift-er-rent-kaos`. (Last accessed April 2017)

Pretorius, M. C., & Calitz, A. P. (2012). The South African user experience maturity status for website design in provincial governments. In *Proceedings of the 12th European Conference on eGovernment, Institute of Public Governance and Management ESADE* (pp. 589–599).

Prosa. (2011). `https://www.prosa.dk/aktuelt/prosabladet/artikel/artikel/et-system-uden-brugervenlighed-er-spildt-arbejde/`. (Last accessed March 2017)

Rambøll. (2013). *It i praksis.* `http://docplayer.dk/4077247-Business-technology-strategi-trends-og-erfaringer-it-i-praksis-2013-i-overskrifter.html`. (Last accessed October 2017)

Rigsrevisionen. (2013). `http://www.rigsrevisionen.dk/media/1943096/brugervenlighed-og-brugerinddragelse-i-offentlige-digitale-loesninger.pdf`. (Last accessed April 2017)

Rigsrevisionen. (2016). `http://www.rigsrevisionen.dk/media/2098255/Besparelsespotentialet-ved-obligatorisk-Digital-Post.pdf`. (Last accessed December 2017)

Ringrose, D. (2011). *How to actually deliver the benefits of a digital society.* `https://ec.europa.eu/digital-single-market/en/blog/how-to-actually-deliver-the-benefits-of-a-digital-society`. (Blog post. Last accessed December 2017)

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: How to plan, design, and conduct effective tests*. John Wiley & Sons.

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Sage.

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design*, *4*(1), 5–18.

Schuler, D., & Namioka, A. (1993). *Participatory design: Principles and practices*. CRC Press.

Shneiderman, B. (2003). *Leonardo's laptop: human needs and the new computing technologies*. MIT Press.

Skov, M. B., & Stage, J. (2005). Supporting problem identification in usability evaluations. In *Proceedings of the 17th Australian conference on Computer-Human Interaction* (pp. 1–9).

Spinuzzi, C. (2005). The methodology of participatory design. *Technical communication*, *52*(2), 163–174.

Stake, R. E. (1995). *The art of case study research*. Sage.

Steen, M., Kuijt-Evers, L., & Klok, J. (2007). Early user involvement in research and design projects — a review of methods and practices. In *23rd EGOS Colloquium (European Group for Organizational Studies)* (pp. 5–7).

Stewart, J. K., & Williams, R. (2005). The wrong trousers? Beyond the design fallacy: Social learning and the user. , 39–71.

Svanæs, D., & Gulliksen, J. (2008). Understanding the context of design: towards tactical user centered design. In *Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges* (pp. 353–362). doi: 10.1145/1463160.1463199

Tamminen, S., Oulasvirta, A., Toiskallio, K., & Kankainen, A. (2004). Understanding mobile contexts. *Personal and ubiquitous computing*, *8*(2), 135–143.

Tarkkanen, K., & Harkke, V. (2015). From usability workarounds to usability around work. In *Proceedings of INTERACT* (pp. 513–520).

Tollmar, K. (2001). *Towards CSCW design in the Scandinavian tradition*. Stockholm University.

van der Panne, G., van Beers, C., & Kleinknecht, A. (2003). Success and failure of innovation: a literature review. *International Journal of Innovation Management*, *7*(03), 309–338.

van Kleef, E., van Trijp, H. C., & Luning, P. (2005). Consumer research in the early stages of new product development: a critical review of methods and techniques. *Food quality and preference*, *16*(3), 181–201.

Venturi, G., Troost, J., & Jokela, T. (2006). People, organizations, and processes: An inquiry into the adoption of user-centered design in industry. *International Journal of Human-Computer Interaction*, *21*(2), 219–238.

Version 2. (2013). *Danskerne gider ikke digital selvbetjening.* `https://www.version2.dk/artikel/borgernes-lyst-til-digital-selvbetjening-falder-53643`. (Last accessed October 2017)

Version 2. (2014a). *Danskerne giver fortabt på hver anden formular på borger.dk.* `https://www.version2.dk/artikel/danskerne-giver-fortabt-paa-hver-anden-formular-paa-borgerdk-55785`. (Last accessed April 2017)

Version 2. (2014b). *Statens it-chef: Brugervenligheden rider os som en mare.* `http://www.version2.dk/artikel/statens-it-chef-brugervenligheden-rider-os-som-en-mare-70689#comment-292503`. (Last accessed March 2017)

Version 2. (2017a). *Danmarks offentlige digitalisering fremhæves på tysk tv som et skoleeksempel.* `https://www.version2.dk/artikel/danmarks-offentlige-digitalisering-fremhaeves-skoleeksempel-paa-tysk-tv-1081772`. (Last accessed January 2018)

Version 2. (2017b). *Sikkerhedshul i kmd-system gav adgang til borgeres lønsedler.* `https://www.version2.dk/artikel/sikkerhedshul-kmd-system-gav-adgang-borgeres-loensedler-1078131`. (Last accessed August 2017)

Virzi, R. A. (1992). Refining the test phase of usability evaluation: How many subjects is enough? *Human factors*, *34*(4), 457–468.

Wangpipatwong, S., Chutimaskul, W., & Papasratorn, B. (2008). Understanding Citizen's Continuance Intention to Use e-Government Website: a Composite View of Technology Acceptance Model and Computer Self-Efficacy. *Electronic Journal of e-Government*, *6*(1), 55–64.

Wasserman, A. I. (1973). The design of "idiot-proof" interactive programs. In *Proceedings of the June 4-8, 1973, national computer conference and exposition* (pp. 34–38).

Wikipedia. (2017). *Kmd.* `https://da.wikipedia.org/wiki/KMD`. (Last accessed October 2017)

Wong, B. (2006). Different views of software quality. *Measuring information systems delivery quality*, 55–88.

Yin, R. K. (2003). Case study research: design and methods, applied social research methods series. *Journal of Applied Ergonomics*, *40*, 731–744.

Ældresagen. (2015). *Digital Kommunikation — Det mener Ældresagen.* https://www.aeldresagen.dk/-/media/aeldresagen-dk/delte/dokumentation/politikpapir/holdning-til-digital-kommunikation.pdf.

Contributions

Contribution 1

E-government and the Digital Agenda for Europe: A Study of the User Involvement in the Digitalisation of Citizen Services in Denmark

Jane Billestrup and Jan Stage

The paper has been published in the
International Conference of Design, User Experience, and Usability,
pp. 71–80, 2014.

The layout has been revised.

Abstract

Several initiatives in regards to digitalisation citizens' services have been launched, both in the European Union and in Denmark. Several problems have been reported in related work in regards to lack of accessibility and usability of e-government self-service solutions. The objective of this paper was "How are software providers developing e-government self-service solutions that should be usable for all citizens?" we conducted 11 phone interviews with self-service providers in Denmark. We found that no citizens are involved in the development process and only few of the self-service solutions are usability evaluated before being released.

1 Introduction

Digitalisation happens at all levels in these years, both The European union, the Danish state and municipalities are digitalising their contact with the citizens in these years. The European Commission has an initiative called "Digital Agenda for Europe" which describes a set of actions for digitalisation of the European Union. Action 64 is named "Ensure the accessibility of public sector websites" the aim of this action is that the public sector websites for citizens should be fully accessible and usable for self-services by 2015 (European Commission, n.d.).

In 2012 Denmark took the first step towards full digitalization of citizens services. By 2015 the goal is that the citizens services websites should not only be accessible, but 80% of all all forms filled out by citizens should be done digitally (Kommunernes Landsforening, 2012).

In Denmark citizen services are developed by a number of private companies and the municipalities are free to buy the systems they feel are the most suitable (Kombit, 2014). Other literature has suggested that people prefer self-service over face-to-face service, primarily because it is possible to save time and effort (Meuter, Ostrom, Roundtree, & Bitner, 2000). But the related work also describe there are some challenges in regards to the digitalisation of citizens' services, which will be elaborated in the related work section.

The research question of this study is "How are software providers developing e-government self-service solutions that should be usable for all citizens?". In our study we have conducted interviews with 11 software providers of digitalized self-services.

The study has been conducted by covering the second of four phases in the digitalisation strategy that is deployed between 2012 and 2015. In this second phase 12 software providers are in play developing software solutions covering 13 areas of citizen sell-services, like application for assistive technologies for handicapped or elderly, application for reporting rats, notification of marriage and ordering a new passport or drivers license.

The following section presents a more detailed description of the work related to this study. It describes the consequences if citizens self-services are not created to be intuitive and usable for all citizens. Section 3 presents the method used for data collection, which consisted of semi-structured qualitative phone interviews. Coding were used for analysing the transcriptions of the interviews. Section 4 presents the results from the interviews. Section 5 provides a discussion of the results in a broader context. Finally, section 6 provides the conclusion.

2 Related Work

This section will provide an overview of the related work, with a clear focus towards which obstacles to overcome if e-government and self-service solutions should be a success, we also look at the results of other studies conducted about evaluations of e-government websites. As no literature was found with a clear objective at the software providers of e-government solutions and how they secure creating solutions that are usable, we identified the largest obstacles and challenges in relation to creating successful e-government websites.

E-government or electronic government can be referred to as "The utilization of Information Technology (IT), Information and Communication Technologies (ICTs), and other web-based telecommunication technologies to improve and/or enhance on the efficiency and effectiveness of service delivery in the public sector." (Hai & Jeong, 2007).

If e-government self-services should be a success and save money for the municipalities the systems need to be created so the citizens trust the e-government sites and feel satisfied using the self-services (Business Wire, 2010; Meuter et al., 2000). Problems have been reported in regards to self-service technologies and the ability to reduce cost operations. Business Wire reported in 2010 that actually the majority of organisations investing in self-service technologies fail to reduce operating costs and experience decreasing costumer satisfaction which means that there are obstacles yet to overcome if e-government websites and self-service solutions should be successful (Business Wire, 2010).

Trust in a government is directly related to e-government web-sites, but not to trust in the technology. Trust towards e-government web-sites are also closely related to the quality of the website, this includes quality of the information, the system and the service. The quality of the e-government website is less important if it is more convenient for the citizens to use the website than other options or if the user can e.g. save time by using the website (Teo, Srivastava, & Jiang, 2008).

User satisfaction can have a great impact on whether a self-service system

is used by the citizens or not (Meuter et al., 2000; Venkatesh, Chan, & Thong, 2012). To keep the users satisfied the system must get the user out of a troubled situation as soon as it appears (Meuter et al., 2000; Weir, McKay, & Jack, 2006). The user needs to get an advantage from using the self-service system, e.g. saving time, ease of use or accessibility. The self-service system needs to do what the user intended the system to do. (Meuter et al., 2000)

To prevent the user from being dissatisfied a self-service system needs to be reliable (Meuter et al., 2000). Failing technology makes users dissatisfied, if the self-service is not reliable that could make citizens decide that they do not trust the system and do not want to use the sell-service system (Meuter et al., 2000). Process failures will increase user dissatisfaction, especially if the failure happens at a time that the citizen believe the process has been a success, when this does get known by the citizen the dissatisfaction will increase and the trust in the self-service system will decrease (Meuter et al., 2000). Poor design can also lead to users being dissatisfied with the system, designing a system like a self-service system only works if the user has been kept in mind during the design process (Xin Ding, Hu, Verma, & Wardell, 2010; Meuter et al., 2000).

The related work shows that e-government websites have been evaluated in scientific research for many years. There is a tendency to citizens services in other countries being designed without attention to quality, accessibility or usability (Abanumy, Al-Badi, & Mayhew, 2005; Aladwani, 2013; Kuzma, 2010; Kommunernes Landsforening, 2012).

The contribution from our study is that we studied what the software development companies do to ensure usability and accessibility in the e-government self-service solutions in Denmark and how they did it. In the following section we describe the method we used for the data collection and how the data was analysed.

3 Method

This study was conducted as a single case study. We approached all software development organisations which were identified as self-service providers for this phase in spring 2013 as involved in developing the software solutions for the second phase. We contacted 12 organisations and 11 organisations accepted to participate in this study and one organisation declined. The companies we interviewed varied in size from 12 employees in a small company only located in Denmark, up to global companies with up to 170.000 employees all over the world.

A total of 11 semi-structured qualitative interviews were conducted as phone interviews. The interviews lasted from 21 to 82 minutes and were conducted between May 30th and July 4th 2013. The length of the interviews de-

pended of the extent of the solutions developed by each organisation. Some organisations only developed one of the 13 solutions while others developed up to seven of the solutions. The length of the interviews also depended on the personality of the interviewee and how much in-depth information and knowledge they had about our main focus areas.

The interviews were recorded and later transcribed. The data was analysed using Dedoose[1]. All interviews were analysed using coding with four coding categories; Development Method, User Involvement, User Evaluation and User criteria.

4 Results

This section presents the findings based on the analysis of the interviews. The findings are divided into four sub-sections that should ensure that we understand all aspects of what the self-service providers do to make sure the solutions are usable to all citizens. We have divided the results into the following sub-sections;

Development method, user involvement, ensuring usability and Supporting the process of the self-service providers.

4.1 Development Method

Eight companies described working agile when creating software solutions. One interviewee described their development process as the following;

"We follow the Scrum method completely, hosting Scrum meetings every day and working in small sprints".

Three companies described that they some times worked agile but other times they used a more traditional development method.

"It varies which development method we use, sometimes we use a method like the waterfall method, other times we use an agile development method like scrum. It depends on various things like if the costumer wishes to be involved as an on-site costumer or not."

We found the development method interesting as agile development methods encourages user involvement. In the following sub-section we will describe how and which users were involved in the development process'.

4.2 User Involvement

The user group contains of two very different types of user groups. On one hand is the citizens who fills out the forms in the self-service solutions. On the other hand is the case workers at the municipalities who receives the

[1] `https://app.dedoose.com/App/?Version=4.5.98`

forms and process' it. First we describe how the case workers are represented and then we describe how the citizens are represented in the development process.

In Denmark there is 98 municipalities, which means that for each self-service solution there is 98 potential buyers in Denmark. This means that the self-service providers does what the can to keep the costumers they have but also tries to get more costumers. This is done by using the self-service solutions to optimize the processes for the case workers to save money for the municipalities.

"Our primary focus is to simplify the work flows for the case workers, other wise this would not be worth the effort".

Six of the self-service providers describe that they host workshops with current costumers. These workshops are used to understand the work flows for the case workers and what could be optimized by creating a new self-service solution.

One interviewee described it as follows;

"On the first workshop we do not present anything, typically we say, teach us – We know nothing...The workshops are typically used to figure out how we digitally can support the digital work flow".

The interviewees describe different variations of the workshops but the principal is basically the same, which is to understand and optimize existing work flows, at least for the first workshop. Some interviewees describe hosting workshops each year to continuously getting new inputs and feedback that can be optimized when the make new releases. Several also describe having a smaller group op users from 1-5 municipalities who are kept on as on-site costumers. They are the ones who are contacted if the software providers have any doubts in regards to the work flows.

"Every time we have a question we ask the small group of municipalities working as our on-site costumer, to tell us if it is the right thing we are doing...This is also typically the municipalities who get the solutions implemented first to test if everything works as it is intended.

It is described that this is a win-win situation as the municipalities get influence on the solutions and the work flows of the self-service solutions. The software providers get access to a lot of insights of the work flows that needs to be supported by the developed solutions.

The citizens are not directly involved in the development of the self-service system, in most cases the case workers are used to represent the citizens;

"We presume that what the municipalities say are correct, we are not in direct contact with citizens, we expect that the municipalities and their case workers know what the citizens need".

Eight interviewees described that talking to the case workers was combined with the use of other tools like personas, scenarios, user stories and

mock-ups, meaning that the combined the data collected from the case workers about the user groups with tools used in their own analysis of the user groups for each self-service solution.

The following sub-section will describe how the self-service providers ensure their solutions are usable for all citizens.

4.3 Ensuring Usability

Nine out of eleven self-service providers believe they are creating systems that are usable as they have hired people with experiences with or an education including usability evaluations, target group analysis' and interface design. In regards to ensuring the developed systems being usable for all citizens, one interviewee stated the following;

"We know if our system is usable by looking at how much the system is actually being used".

Two other interviewees both described that their experience was that if the citizens wanted something from the municipalities they would get through all steps of a self-service solution if it was usable or not;

"We discovered that for 80% of our self-service solutions only 10% of the people who started filling out the form also finished and submitted their form. For the last 20% we found that 80% of the citizens who started filling out the form also submitted it to the municipalities. We found that those 20% was all services were the citizens would get money from the municipalities."

The point was that the focus on usability might be a bit overrated as the citizens can fill out the forms if they really want to, usability or not.

Usability evaluations are conducted to some extent by three of the self-service providers. One also states that they always conduct a usability if they are developing a new system from scratch. One of the self-service providers described that the system would be user evaluated by one municipality, the test would be conducted at the library where citizens would simply be approached and asked to participate. The self-service providers who conducted usability evaluations mainly described finding test persons that was employees at the municipalities. One interviewee described that one municipality sent out an email out to all employees asking if they fit a defined profile they should reply. E.g. when they wanted to user evaluate the solution in regards to issuing a marriage certificate they emailed all employees asking if some of them were getting married in a near future.

To ensure usability and accessibility some guidelines were created to support the self-service providers in their development process. These will be described in the following sub-section.

4.4 Supporting the process of the self-service providers

The municipalities' joint IT organisation have developed some materials to support the self-service providers in creating usable systems. The purpose is to ensure that the citizens are kept in mind during the development process of the self-service solutions.

They have e.g. developed 24 Usability criteria (Kombit, 2011) that all self-service solutions are encouraged to comply with though it is not mandatory. Among these criteria are e.g. keeping all text short clear and using simple language. Another criteria is about that the user should always see a status bar so the citizens will know how many steps they have left.

The responses we got from the self-service providers was very mixed. Some thought it was overkill e.g. "Too many pages was spent to describe something that is actually a pretty elementary flow".

Three interviewees indicated that the thought it was wishful thinking to think that usability could be ensured by creating 24 usability criteria. Corresponding with that another interviewee stated;

"Just because the self-service solutions live up to these 24 usability criteria does not mean the solutions will actually be usable, there could be other problems with the self-service solution getting in the way of that".

The same interviewee also stated that it was very important that the self-service solutions were created focusing on usability, but they does not rely on this kind of material to ensure usability as there might be a new and better way to do that than what is stated in these criteria. Others liked the criteria because they could use the criteria as a check list. The criteria were described as being a collection of common sense, but now they have a good reason to ensure these things are implemented.

The idea behind the user story was to make sure that the self-service providers understood the citizens and their needs in each of the solutions and to make sure the self-service providers kept the citizens in mind through the development process. The user stories were created as a pamphlet with drawings and text describing a citizen and the process of filling out a form on the self-service system. The user story described a scenario in regards to the use situation but was not bound to what is possible right now, it described a vision of what the future could be like. Eight of the self-service providers described it as being confusing either to them or to the municipalities. One interviewee stated;

"As a lot of actors are quite new both self-service providers, the solutions and digitalisations consultants at the municipalities. People might view the user stories as the answer, which causes confusion...I feel that in some situations the municipalities got the impression that we as self-service providers could not implement the visions that the municipalities joint IT organisation have.

Nine of the self-service providers expressed satisfaction with the idea behind the user stories, and felt it was the right way to go.

"If you just start with a specification of requirements, you might not end up with the product the users actually need, so I think this is the right way to go. The details just need to fit the reality.

The self-service providers are very positive about the initiative but find that there is room for improvement. Also that the self-service providers should have been included in the process of the development of the user stories by e.g. interviews as that might have made it easier for them to use as part of their development process.

A large issue which was adressed by six interviewees was that the user story only described one of many paths through the system. For examle applying for a marriage certificate, the scenario in the user story is two Danish citizens – a man and a woman sitting together, but other scenarios include same sex marriage, one or both being foreigners, one being deployed, etc. One interviewee stated that the user story made him believe that the solution would be more simple than it turned out to be during the analysis phase which turned out to be a problem for them.

The following section will sum up our results and discuss these in relation to other literature.

5 Discussion

Next, the results will be discussed in relation to the issues described in the related work. Scrum is the primary development method used to develop the self-service solutions, with short iterations, sprints and an onsite costumer.

The onsite costumer is case workers from the municipalities, their responsibilities are both in regards to the underlying system the case workers will use, but they also have a responsibility to ensure usability and accessibility of the self-service solution that the citizens' will have to use, as they are working as ambassadors for the citizens.

Several self-service providers stated that they believed the case workers knew the needs and requirements of the citizens very well. It does make sense that the case workers are part of this process as they have the expertise to know what kind if information the citizens need to register for them to do their job most effectively, but it does raise a flag in regards to creating usable and accessible self-service solutions as they might be expert users and not being able to see problems related to less experienced users. Several of the self-service providers described having usability experts in house and that they also used tools like personas, scenarios, user-stories and mock-ups to get an understanding of the users and their needs before developing the self-service systems. Whether the self-service solution actually fits the citizens

are not tested before the self-service solution has been finalized, if it is even tested at all. Youngblood and Mackiewicz (2012) concluded that the most efficient and cheapest way to fix problems is during the design phase and not after deployment. As the case worker is the ambassador for the citizens problems might not be found before the solution has been deployed and then the problems will be harder to fix and cost a lot of money. This could be avoided if the system was user evaluated as paper prototypes using citizens as test persons (Rubin, 1994).

Several interviewees stated that if the citizens were to get something from the municipalities, e.g. free day care or a new passport, then they would be able to use a self-service system whether the system was usable and accessible or not which corresponds with Teo et al. (2008) as they found that the quality of the e-government website was less important if it was more convenient for the citizens to use the website than other options they might have.

The plan in Denmark is that at one point citizens will be obligated to use the self-service solutions if they need anything from the municipalities. The citizens will have to get through filling out the forms no matter what. The problem is if the citizen think they have filled out the form and sent it to the municipality, but an error occurred. Another problem is that in Denmark alone 500.000 people have never used the internet, of these 400.000 people are more 65 years old (Danmarks Statistik, n.d.). This could cause a much greater problem as these people might not be able to use an online self-service system at all and there need to be found another strategy for these citizens.

The usability criteria are primarily described as stating the obvious by the interviewees but a fine check list to make sure all requirements have been met, even though a concern was raised, if the self-service solutions is more usable for the citizens because they are living up to these criteria. On the other hand the criteria could mean better accessibility as several of the criteria evolve around accessibility.

The fact that the criteria exist is supported by Abanumy et al. (2005) as they believe guidelines for accessibility should be developed for e-government solutions.

The user stories are perceived as a good idea but also that it needs some more work before they will actually make a difference, also that the user stories was too narrow as they only described one of many scenarios.

The fact that usability and accessibility are being addressed in the development of the self-service solutions is very positive but there are definitely room for improvements in regards to the initiatives since the plan is to make it a requirement for all citizens to use self-service solutions in a foreseeable amount of time.

6 Conclusion

The purpose of this paper was to understand how software providers are developing e-government self-service solutions that should be usable for all citizens. To accomplish this we conducted 11 phone interviews with the self-service providers.

The study showed that no citizens are involved in the development process as the case workers are used as ambassadors for the citizens. Some systems are user evaluated after the system has been developed but the majority releases the system in a few municipalities and wait to see which problems are being reported back to them.

Our findings show what happens during the development process, where the related work evolves around the final product. We conducted a close to complete study as 11 of 12 self-service providers have participated in this study.

The limitations of this study is that we have not been focusing directy on the self-service solutions being developed as they where released six months after this study was conducted. This will be the focus of another study we will conduct spring 2014.

Acknowledgment We would like to thank the companies and employees that participated in our questionnaire survey and Infinit for supporting the research.

References

Abanumy, A., Al-Badi, A., & Mayhew, P. (2005). e-Government Website accessibility: in-depth evaluation of Saudi Arabia and Oman. *The Electronic Journal of e-Government*, *3*(3), 99–106.

Aladwani, A. M. (2013). A cross-cultural comparison of Kuwaiti and British citizens' views of e-government interface quality. *Government Information Quarterly*, *30*(1), 74–86.

Business Wire. (2010). Recent ICMI and inContact Survey Reveals Contact Centers Spending More on Self-Service Solutions, but not Realizing Forecasted Results. *Business Wire, New York (December 17)*.

Danmarks Statistik. (n.d.). `http://www.dst.dk/da/Statistik/emner/informationssamfundet/it-anvendelse-i-befolkningen.aspx`. (Last accessed 05-02-2014)

European Commission. (n.d.). http://ec.europa.eu/digital-agenda/en/pillar-vi-enhancing-digital-literacy-skills-and-inclusion/action-64-ensure-accessibility-public. (Last accessed 29-10-2013)

Hai, C., & Jeong, I. (2007). *Fundamental of development administration*. Selangor: Scholar Press.

Kombit. (2011). *Criteria for usability in self-service solutions.* http://www.kl.dk/ImageVault/Images/id_56064/scope_0/ImageVaultHandler.aspx. (The government agency for digitalisation in Denmark, Last accessed 07-01-2018)

Kombit. (2014). http://www.kombit.dk/indhold/leverand%C3%B8rer. (Last accessed 27-01-2014)

Kommunernes Landsforening. (2012, June). http://www.kl.dk/Administration-og-digitalisering/Lov-om-obligatorisk-digital-selvbetjening-og-digital-post-er-vedtaget-id105354/. (Last accessed 07-01-2018)

Kuzma, J. M. (2010). Accessibility design issues with UK e-government sites. *Government Information Quarterly*, *27*(2), 141–146.

Meuter, M. L., Ostrom, A. L., Roundtree, R. I., & Bitner, M. J. (2000). Self-service technologies: understanding customer satisfaction with technology-based service encounters. *Journal of marketing*, *64*(3), 50–64.

Rubin, J. (1994). *Handbook of Usability Testing*. John Wiley & Sons.

Teo, T. S., Srivastava, S. C., & Jiang, L. (2008). Trust and electronic government success: An empirical study. *Journal of management information systems*, *25*(3), 99–132.

Venkatesh, V., Chan, F. K., & Thong, J. Y. (2012). Designing e-government services: Key service attributes and citizens' preference structures. *Journal of Operations Management*, *30*(1), 116–133.

Weir, C., McKay, I., & Jack, M. (2006). Functionality and usability in design for estatements in ebanking services. *Interacting with Computers*, *19*(2), 241–256.

Xin Ding, D., Hu, P. J.-H., Verma, R., & Wardell, D. G. (2010). The impact of service system design and flow experience on customer satisfaction in online financial services. *Journal of Service Research*, *13*(1), 96–110.

Youngblood, N. E., & Mackiewicz, J. (2012). A usability analysis of municipal government website home pages in Alabama. *Government Information Quarterly*, *29*(4), 582–588.

Contribution 2

Creating and Using Personas in Software Development Practice

Jane Billestrup, Jan Stage, Lene Nielsen and
Kira Storgaard Hansen

The paper has been published in the
International Journal on Advances in Software, Vol. 8(1–2), pp. 1–10, 2015.

The layout has been revised.

Abstract

Personas have been suggested as a strong technique for providing software developers with a deep understanding of the prospective users of a software system. This paper reports from two separate but related empirical studies. The first study was a questionnaire survey about Personas usage in software development companies. The purpose was to uncover to what extent and in which ways Personas are used in software development companies located in a specific geographical area. This study demonstrated that less than half of the respondents had ever heard about Personas. We also identified key obstacles towards the use of the technique: lack of knowledge of the technique, lack of resources, sparse descriptions and scarce integration in development. The second study was based on detailed interviews with four software developers about their usage of Personas in development processes in the software industry. We identified basic practices in Personas creation and usage and found that the respondents understand Personas creation and use differently from the practice described in the literature. In fact, developers are evolving their practices for creating and using Personas.

1 Introduction

This paper is an extended version of the paper "Creating and Using Personas in Software Development Practice: Advantages, Obstacles and Experiences" (Billestrup, Stage, Nielsen, & Hansen, 2014).

Personas are being promoted as a technique that supports design and engineering of interactive software systems with an explicit focus on the prospective end-users.

The general definition of the technique is that a Persona is a description of a fictitious person based on data collected about the target user group of a system (Cooper, 2004; Pruitt & Adlin, 2010). The common way to represent a Persona is as a text describing, and usually also a photo depicting, the fictitious person (Cooper, 2004; Nielsen, 2003).

The main idea for introducing Personas is consistent with results from numerous reports that have documented that software developers lack knowledge and understanding of their users, their work, and their goals, e.g., (Bak, Nguyen, Risgaard, & Stage, 2008; Bruun & Stage, 2012). A consequence is that when a system has been developed, it does not fulfil the needs of the users and is incompatible with their work processes. The Personas technique has been suggested as a strong tool to overcome these problems by providing software developers with a specific understanding of prospective end-users of their software (Cooper & Reimann, 2003).

It has been argued that the use of Personas provides software developers with empathy for, and engagement in, the end-users of the software solution

(Nielsen, 2004). There is also literature that concludes that the use of Personas has been a success (Cooper, Reimann, & Cronin, 2007; Dotan, Maiden, Lichtner, & Germanovich, 2009).

The literature includes several conclusions about the benefits of the Personas technique if it is used to its full potential. Matthews, Judge, and Whittaker (2012) found that the designers who had a very positive attitude towards Personas were primarily those who had done extensive work with Personal, and had some training in the creation of Personas, and used them as prescribed by the literature. The Personas technique is not yet incorporated as an integrated and general part of the toolbox in the software development industry (Matthews et al., 2012). It has been documented that the main reason for this is that many developers in the industry have problems using Personas in practice (Blomquist & Arvola, 2002). Thus, there are still many unanswered questions about the actual advantages of using Personas in software development practice. The strength of using Personas compared to other techniques are also unexplored.

The purpose of this paper is to inquire into the way in which software companies use Personas and whether the technique is used as proposed in the literature. We report from a questionnaire survey and a case study of experiences with the creation and use of Personas in software development practice. The questionnaire survey (Study A) was conducted in a delimited region in Denmark, where we inquired into the experiences software companies in this region had in using Personas and incorporating the technique as a part of their development toolbox. The case study (Study B) was based on interviews with four developers who were or had been working with Personas in practice. Our focus in this paper is on comparing the literature with the experiences and the perceived strengths and weaknesses of the Personas technique from the perspective of the software development industry. Our empirical basis includes using a mixed method approach involving both quantitative and qualitative data collection.

Section 2 presents a more detailed description of work related to this study. It describes how Personas are created and used, including the pitfalls to avoid. Section 3 describes the method used in the questionnaire survey (Study A). Section 4 presents the results of this survey. Section 5 presents the method used in the case study (Study B). Section 6 provides the findings derived from the interviews. Section 7 compares the findings from the two studies and discusses the results compared to experiences about Personas reported in the literature. Finally, Section 8 provides the conclusion.

2 Related Work

The literature offers four different perspectives regarding the basis for and role of Personas (Nielsen, 2012): 1) Cooper's goal-directed perspective 2) Grudin, Pruitt and Adlin's role-based perspective 3) the engaging perspective, which emphasises how the story can engage the reader. These three perspectives agree that the Persona descriptions should be founded on real data. However, 4) the fiction-based perspective, does not include data as a basis for Persona description but creates Personas from the designers' intuition and assumptions. Even though the Personas technique has been around for more than a decade, when comparing the four perspectives, it is still unclear what and how much background material is required to create Personas (Nielsen, 2013).

The commonly perceived benefits of Personas, when designing products are two-fold: 1) the technique facilitates that designers remember that they are different from the end-users, and 2) the technique enables designers to envision the end-users' needs and wants. Furthermore, in the design process Personas increase the focus on users' and their needs. The technique is an effective communication tool, which uses the Persona description to acquire direct design influence and lead to better design decisions and definition of the products' feature set (Cooper, 2004; Pruitt & Adlin, 2010; Cooper & Reimann, 2003; Dotan et al., 2009; Long, 2009; Ma & LeRouge, 2007; Miaskiewicz & Kozar, 2011).

The literature includes a rich variety of guidelines and experiences about the use of Personas.

Defining Personas

The literature originally defined a Persona as a text and a photo describing the character (Cooper, 2004; Cooper et al., 2007). Later developed into posters, websites and hand-outs (Pruitt & Grudin, 2003). Personas are considered to be most useful if they are developed as whole characters, described with enough detail for designers and developers to get a feeling of its personality (Cooper & Reimann, 2003; Blomquist & Arvola, 2002; Pruitt & Grudin, 2003). The benefits of Personas are that they enable designers to envision the end-users needs and wants, reminding designers that their own needs are not necessarily the end-users' needs, and provide an effective communication tool, which facilitates better design decisions (Dotan et al., 2009; Long, 2009; Ma & LeRouge, 2007; Miaskiewicz & Kozar, 2011).

Creating Personas

Before creating Personas, a comprehensive study of the target user group is suggested. It has been recommended to acquire this information through interviews with the target user group (Levin, 2004) or observational studies of them (Quesenbery, 2004). Yet Chapman and Milham argue that it is not possible to verify that the created Personas reflect the target user group (Chapman & Milham, 2006). It has been suggested to create 3–5 Personas (Adlin & Pruitt, 2010; Friess, 2012), but the amount of users one Persona can represent has been questioned (Chapman & Milham, 2006).

Personas Critique

Personas have been characterised as unreliable and preventing designers from meeting actual users (Bak et al., 2008; Blomquist & Arvola, 2002; Nielsen, 2012). Problems have been reported regarding creation and distribution of the developed Personas (Blomquist & Arvola, 2002; Pruitt & Grudin, 2003). The descriptions have been perceived as unreliable and not well communicated. Also, developers lack understanding of how to use Personas (Pruitt & Adlin, 2010; Blomquist & Arvola, 2002; Pruitt & Grudin, 2003). The technique itself is criticised for being too founded on qualitative data and, as a consequence of that, being non-scientific, being difficult to implement. Also, for not being able to describe actual people as it only portrays some characteristics, and for preventing designers from meeting actual users (Bak et al., 2008). Moreover, the unsolved question about how many users one Persona can represent is emphasised as problematic (Chapman & Milham, 2006).

Some have tried to prevent poor use of the Personas technique, e.g., Faily and Flechais (2011) describe regularly sending information about the Personas to the development team, to ensure that the designers and developers consider the Personas in the design process. They also suggest that the creators should hand over instructions and provide tools that support the developers' usage (Faily & Flechais, 2011). Problems in applying Personas are reported as also involving the mindset of the developers, which is documented by both Blomquist and Arvola (2002), and Pruitt and Adlin (2010).

Matthews et al. (2012) focused mainly on designers and user experience professionals who had some training in Personas creation and had done extensive work with Personas using them as described by others (Cooper, 2004; Pruitt & Adlin, 2010). These designers had a very positive attitude towards the technique. Those who had done minor use of Personas had a moderate or neutral opinion regarding Personas, and those who had not worked with Personas at all had a negative or indifferent opinion regarding the technique.

The use of the Personas technique in software development processes, e.g., by combining Personas and agile development like XP, has also been

explored. In this case, the customer preferred a Persona without a picture, merely describing a job title and maybe a name, but Powell et al. do not support this as it will take away the developers' empathy for the users. Moreover, by using Personas integrated with XP, the developers felt confident to make decisions without involving the on-site customer every time (Powell, Keenan, & McDaid, 2007).

Personas in Practice

An inquiry of design teams in 13 Danish multinational companies reports that Personas help keep the focus on user needs instead of what the developers and designers like and help in gaining an understanding of how the product can create value for end-users (Nielsen, Nielsen, Stage, & Billestrup, 2013). A different study describes how designers are using Personas contrary to the original intended usage; instead of creating Personas on research results, designers tend to base the Personas on their experiences and thoughts (Chang, Lim, & Stolterman, 2008). This will make it even harder to ensure that the right Personas are created to represent the relevant user groups (Nielsen, 2004). Problems in application of the Personas technique caused by the mindset of the developers have also been reported (Pruitt & Adlin, 2010; Blomquist & Arvola, 2002). It has been suggested to overcome this by regularly sending information about the Personas to the development team (Pruitt & Grudin, 2003; Faily & Flechais, 2011). It seems difficult in practice to avoid making stereotypes when creating Personas, and using Personas does not seem to solve the problem that Cooper originally intended to solve (Turner & Turner, 2011).

3 Study A: Method

To inquire into the usage of Personas, we conducted a questionnaire study in 60 software development companies. We chose to focus on a well-defined geographical area to allow us to do as complete a survey with as many companies as possible, and thereby achieve complete coverage of software companies in that area. The focus on one defined region is that it allows us to establish contact with all companies located in the region. This provides a complete picture than randomly picking out companies located in several regions or even countries. We made considerable efforts to identify and contact all companies in the area. The selection of companies would be more random if we chose a larger geographical area.

3.1 Participants

We focused on companies that were developing software, either for internal or external use. We ended up with software companies with the following characteristics: The company either

- develops software with a graphical user interface (e.g., mobile phones, games, web applications, PC or PDA software),
- develops software for customers or internal use and is geographically located within the defined geographical area, or
- employs more than a single person and it is not a hobby company.

List used to find companies	**Total number of companies on list**	**Out of scope or gone out of business**	**Relevant companies**
List 1	77	−35	42
List 2	139	−63	76
LinkedIn	16	0	16
Total			**134**

Table 2.1: The number of relevant companies.

To obtain a list of as many software development companies as possible we acquired two lists containing software companies located in the chosen region. These lists were from a previous study of companies (List 1) and an industry network (List 2). This was followed by a search on LinkedIn to include companies that only had a smaller development department in the region and had their headquarters located either in another region or another country. Table 2.1 shows the total number of software companies in the region, which were within the scope of this study.

3.2 Data Collection

We created an online questionnaire using the tool SurveyXact[1]. The first part of the questionnaire was made to gain information about the respondent and his or her place of employment (e.g., job function, business, number of employees in the company and line of business, within software development). The second part was designed to uncover if the respondents knew what a Persona was and what it was used for. The third part was about the use of Personas in the companies. This part was only filled out by the people who answered that they knew of, and worked with, Personas. The questionnaire

[1] `http://www.survey-xact.com`

consisted of 35 questions, but only respondents who knew of and was working with Personas in their current employment got to answer all 35 questions. The questionnaire consisted of both open and closed questions.

The distribution of the questionnaire was done in two ways. First, 43 companies in which we had a known contact person was contacted by phone. Then the remaining 91 of the 134 companies were contacted to acquire a contact person. Eight of these declined to participate and 14 we could not locate a viable phone number or email address. This resulted in 112 emails being sent out with a link to the questionnaire. The recipients were given three weeks to fill out the questionnaire survey. The data collection process resulted in 69 responses in total. Of the 69 respondents, nine did not finish the questionnaire, leaving us with 60 complete responses. The nine who did not complete the questionnaire were mainly CEO's in small companies. These respondents mainly stopped filling out the questionnaire after entering their personal details.

The responding companies were asked to characterise their main line of business. The distribution is shown in Table 2.2.

Characterization of companies	**Number of answers**
Software development	44
Design and development	4
Financial services	2
Marketing and advertisement	2
Game development and entertainment	1
Telecom	2
Web development	4
Other line of business	1
Total	**60**

Table 2.2: The distribution of the companies after line of business.

Table 2.2 shows that the respondents prevailingly characterise their main line of business as software development.

3.3 Data Analysis

Data analysis was conducted continuously while the questionnaire was still open for submissions, as suggested by Urquhart (2012). When the questionnaire was closed, the data was updated with the results from the latest incoming questionnaires.

In the questionnaire, we used both open and closed questions. All responses to closed questions were analysed quantitatively. For the open questions, the grounded theory approach, as described by Corbin and Strauss

(2008), Urquhart (2012) and Urquhart, Lehmann, and Myers (2010), was used as the analysis method. The aim of grounded theory is described as "building theory, not testing theory" (Pace, 2004). This means that theory should emerge while the analysis takes place and should not be used to prove an already existing theory.

Open Questions: Coding was used to analyse the open questions. One question was: "How would you explain what a Persona is and how it is used?". For this question, the following coding categories were assigned: technique (for creating Personas), finding target user group, when in the process the Personas are used and how they are used. Grounded theory coding was not used for other open questions since the respondents mainly answered in very short sentences and they were sent directly to the end of the questionnaire when answering "No", e.g., "Have you ever heard about Personas?" or "Have you ever worked with Personas?" meaning that the number of respondents dropped for every question. As it makes no sense to ask a respondent about their knowledge about the use of Personas if they have already indicated they have never heard about Personas.

Closed Questions: Statistics was produced directly from the closed questions.

4 Study A: Results

This section presents the results of the questionnaire survey. It is divided into two sub-sections. 'Knowledge about the Personas technique' is referring to the first part of the questionnaire. This subsection reports if the Personas technique has been adopted by the software developing companies in the defined region. The second subsection "The understanding of Personas and their use" is dividing the obstacles towards Personas usage into four main areas.

4.1 Knowledge about the Personas technique

The results of the questionnaire indicate that 27 out of 60 respondents, or 45%, have heard about Personas. Fourteen respondents out of 60 have worked with Personas. Seven respondents out of 60 are using Personas as a development tool in their current job. This can be seen in Table 2.3.

Meaning that 11.5% of the responding companies are currently using Personas as a development tool and 55% of the respondents have never heard about the technique.

Knowledge about Personas	Number of respondents
Heard about Personas	27 out of 60
Have Worked with Personas	15 out of the 27
Are using Personas in current job	7 out of the 15

Table 2.3: Distribution of Respondents and knowledge about Personas

Number of companies	1–10	11–50	51–200	200<	Total
Using Personas	1	3	1	2	**7**
Not using Personas	23	16	8	6	**53**
Total	**24**	**19**	**9**	**8**	**60**

Table 2.4: Distribution of Respondents on Company Size.

The distribution across different sizes of companies is shown in Table 2.4, showing the number of respondents familiar with Personas.

In Table 2.5, the 53 responding companies that do not use Personas have been grouped. It shows that 33 respondents have never heard about Personas. Three of the organisations did use Personas at some point but stopped. One respondent stated his organisation used Personas in a project where they collaborated with a group of university students, but did not find the Personas technique useful for other projects. The other two respondents stated that their respective companies stopped using Personas because they did not find the developed Personas applicable to their line of development. 13 respondents stated they had heard about the Personas technique but had never worked with creating Personas themselves and four respondents had worked with creating Personas in earlier employment or while studying.

Knowledge about Personas	1–10	11–50	51–200	200<	Total
Never heard about Personas	18	7	6	2	**33**
Heard about Personas, but never used them	4	5	2	2	**13**
Worked with Personas in other employment or while studying	1	2	0	1	**4**
Have used Personas, but stopped	2	1	0	0	**3**
Total	**25**	**15**	**8**	**5**	**53**

Table 2.5: Respondents' knowledge about personas in companies that do not use them.

Job title of respondents	Not working with Personas in current employment	Currently working with Personas
CEO, CTO, Owner	12	4
System developer or consultant	11	1
Project, Product or Sales manager	16	0
Business architect, Communication and PR	8	0
UX or Web Designer or Manager	6	2
Total	**53**	**7**

Table 2.6: Distribution of Job Titles of Respondents

4.2 Understanding of Personas and their use

An open question in the questionnaire was analysed with coding to reveal all the participating companies' understanding of the term "Persona". "Personas being an imaginary user", were expressed by 22 respondents, e.g., "a fictitious user of the system you are developing". "Personas are used as a validation of the design", were expressed by 17 respondents, e.g., "making sure user needs are met by a given design".

A Persona "being a representation of a larger user segment" was expressed by 13 respondents, e.g., "description of a set of characteristics characterising a certain group of users' behavioural patterns". Personas "being a tool for making sure to keep the users and their needs in mind all the way through the development process" were recognised by four respondents, e.g., "[...] the Personas are used as focus points for planning the entire product life cycle". This means that Personas by far are recognised as fictionalised users used as a tool for designing features requested by users and user segments. On the other hand, no more than four respondents expressed that Personas should be used through the entire development cycle. This means that the common idea seems to be that Personas are mainly a tool for identifying some aspects of the user group and not so much a tool to be used during the entire development process.

Lack of Knowledge (of the technique): Lack of knowledge about the Personas technique seems to be a major obstacle regarding usage of Personas as shown in Table 2.3. The analysis showed that 55% of the respondents had never heard about the concept or technique. Of the re-

spondents who had never heard about Personas, ten people were CEOs, owners or partners (primarily in micro- or small-sized companies), five were managers in IT, and three worked as sales managers (all three in medium-sized companies). In Table 2.6, the respondents' job titles have been divided into groups based on whether the company is currently working with Personas, or not. This indicates that the chance of allocating resources to Personas development might be slim. One respondent indicated that the company did not recognise the importance of any communicative tools. "The company has downsized and has eliminated the communications position since it is primarily a production company, and they do not understand the importance of, e.g., Personas, ambassadors, first movers, e.g., or communication in general for that matter". This means that in these companies the knowledge about the Personas technique will not come from management, and even if employees bring the knowledge about Personas into the companies, funding will probably not be allocated. On the other hand, as seen in Table 2.4, in the seven companies currently working with Personas four respondents was CEO, CTO or owner.

Lack of Resources (time and funding): The analysis found that Personas are mainly created if a need has been identified for a specific project and "cutting a corner" when using Personas seems to be a general idea. Some only use Personas to the point that they think it creates value for the customer and thereby, profit for the company. Also, when asked in the survey how much resources were allocated to develop Personas, the general answer was zero.

Sparse descriptions: When a Persona is created too superficially the Persona will lack the depth that would normally be the strength of the technique, making the Personas untrustworthy and unusable. This contradicts with what helps making Personas useful tools that lead to better design decisions (Cooper, 2004; Pruitt & Adlin, 2010; Long, 2009; Ma & LeRouge, 2007; Miaskiewicz & Kozar, 2011). When a Persona is created with much detail and described as a whole character, and not a stereotype, it will support the design and innovation process. One respondent indicated difficulty in finding a suitable template for the descriptions and that they wanted to create short descriptions instead of detailed character descriptions. "It is hard to find good templates for constructing Personas. We ended up with a few lines in bullets describing each Persona, which could be used as a fast reference. Instead of a large scheme describing lots of details nobody wanted to read anyway". This corresponds to the descriptions of Personas by some respondents answering the questionnaire. These descriptions were quite superficial and did not describe individual Personas but mainly a job role and a

use situation.

Not integrated in the development: This ties-in with the finding of lacking resources. The superficial Personas are created to be used in the design process. The descriptions are not meant to be used in any other stages of the design process. Furthermore, they are not used to keep reminding neither developers nor designers about the end-users and their needs. This means that the potential of the Personas technique is not explored.

4.3 Advantages of using Personas

The respondents currently using Personas described why their companies are using Personas as follows: "to support the development of a system that is easy to use for types of user [...] It is very important to us that the system will be very easy to use, which is why a mapping of the various user groups are important".

Another respondent stated: "Internally in the company, Personas are used to communicate characteristics of the customer segments that we want to focus on especially". Yet another respondent stated that "Personas are primarily used for optimising the product". These advantages correspond with the advantages identified in the related work section.

5 Study B: Method

We have conducted a case study about the use of Personas as a development technique in four software development organisations, including if, and how practitioners perceive Personas and how they use this technique in practice.

5.1 Respondents

From Study A software developers were identified, who had different types of experience using Personas as part of the software development process. Four kinds of software developers were identified, who had different experiences and perceptions in regards to using Personas. One software developer from each category was identified and asked to participate in this study. The four different types are described as follows;

R1 wants to start using Personas as a development technique,

R2 has formerly used Personas as a development technique,

R3 is currently using Personas as a development technique,

R4 knows about it but never used it as a development technique.

The respondents were working as software developers or project managers. None of them had any education in user experience. All respondents had worked in the industry for at least ten years and been in their current organisation for at least two years. All four interviewees use an agile software development method in their current organisations. All are using SCRUM or an adjusted version of SCRUM.

5.2 Data Collection

The four interviews were conducted as semi-structured qualitative interviews (Kvale, 1997). The interviews were recorded and later transcribed. Each interview lasted between 22 and 55 minutes. All interviewees were asked about their educational background and their current and previous job functions. Through the interviews, the interviewees' knowledge about and previous experiences with the Personas technique was explored.

5.3 Data Analysis

All interviews were analysed using grounded theory (Corbin & Strauss, 2008; Urquhart et al., 2010) and open coding with the Dedoose tool[2]. This resulted in the following seven categories;

- Learning to Create Personas
- The Basis for Creating Personas
- Usefulness of Personas
- Strengths of Personas
- Redundancy of Personas
- Weaknesses and Limitations of Personas
- Personas and other techniques

These seven categories were used to categorise the findings.

6 Study B: Findings

This section presents the findings based on the analysis of the interviews. The findings are divided into seven sub-sections in accordance with the coding categories.

[2] `http://www.dedoose.com/`

6.1 Learning to Create Personas

The respondents learned about the Personas technique in different ways. Their first meeting with Personas seems to mainly have happened by chance. Two respondents describe it this way:

> R2: The first time I heard about Personas was at a session at the universities' humanities department four or five years ago. [...] Microsoft has created some Personas describing the users some years ago. They encourage us, as Microsoft consultants, to use these in our development process.

> R1: I have a background as a software developer, but in my former employment I worked very closely with user experience designers.

One respondent described coming from a smaller company where he learned about several usability techniques and why it is important to understand and represent the users' in the development process.

None of the respondents learned about Personas and other User-Centered Design or Usability techniques through education.

6.2 The Basis for Creating Personas

The respondents use different ways of collecting data for the creation of Personas. Yet all of them depend either on information they already have or information their customers have.

> R1: If we do not have enough information ourselves to create the Personas we will ask our customers about their usage of the existing systems.

None of the respondents gets money or time allocated specifically to gather information about the target user group, which is why they have to make use of the information they already have themselves or they can get from their customers.

Another respondent explained that due to not having a budget for data collecting, he was creating Personas a bit differently than suggested by the literature. He primarily thought about the existing users and the archetypes that were standing out.

> R3: We know our users quite well. Our Personas are based on real users, like "can this user understand this?" We use them like Personas archetypes, and we do not use Personas formalised — unformalized we use Personas quite a lot. Personas are based

> on the users who are critical towards our system; the people that make noise if they have a problem.

Another respondent described making Personas that were short and without much detail.

> R2: To me, a Persona does not have to be too detailed in the description of the person.

None of the respondents remembered reading specific literature about Personas. They had mainly learned the do's and don'ts about Personas from others, or from their own experiences.

6.3 Usefulness of Personas

Personas are considered particularly useful when the developers are missing information about the users and their needs. As all four respondents are employed in companies that use an agile development method, they usually work with an onsite customer. Personas were found particularly useful if they did not have an onsite customer on a project. The greater the distance between the users and the designers and developers the more useful Personas are considered to be. One respondent explained that he found Personas very useful as a substitute for onsite customers:

> R1: If there is no onsite customer or employee that knows the field we are developing very well, Personas seems to be very usable. The further the designers and developers are from the users, the more value Personas can bring to the development process.

Another respondent described Personas as a useful tool if there was a geographical distance between designers and developers. This was meant as Personas could help the developers remember the end-users during the development process. So instead of the design team present to make sure the developers focused on the end-users, Personas could do the same thing, if the Personas was made visible to the developers.

> R3: I find Personas useful if the distance between designers and developers is substantial and they are not working side by side all day.

One respondent described that his company does considerable work for the health sector, and they used to have a former nurse employed to help them understand that domain. However, this was no longer an option, so they needed to find new techniques to bring an understanding of the user

groups into the development process. He thought Personas could be used for exactly that.

Another respondent described Personas as useful when developing software solutions for very specific user segments.

> R2: We are creating ERP solutions. I feel that Personas are a relevant tool for us. Because we are developing very specific software solutions for our customers.

This respondent also outlined different opinions about the usefulness of Personas and other techniques in regards to User-Centered Design;

> R2: One of my colleagues approached me one day and said the following "we live by creating solutions, not drawings." I understand his position, but personally, I feel that drawing up the organisation first can help me understand their needs.

Other respondents described similar experiences of colleagues having different opinions in regards to using User-Centered Design techniques or Usability theory in regards to software development.

6.4 Strengths of Personas

The respondents expressed different expectations about the benefits of using Personas in the development process. The respondents were asked to describe situations in which the Personas technique would have been beneficial.

> R4: I believe using Personas would have helped us develop a more user-friendly system.

Personas are also perceived as a strong tool for ensuring the software developers keep the end-users in mind during the development process.

> R1: Personas can help keeping the developer's focus on the users' needs. Personas will provide the software developer with the ability to understand the users' perspective.

> R2: I think that Personas can provide the security for us not developing the wrong system for our user group.

One respondent added that he found Personas especially useful if using a development method like the waterfall method. He argued that when using the waterfall method, the developers have only one possibility to get everything right.

> R3: If using the waterfall development method you have to get everything right the first time. When developing agile, it is not as critical if we make a mistake, we can change that in the next iteration as a new iteration starts every two weeks.

The respondents find that a strength of the Personas technique is that it can support the developers in developing software that lives up to the users' requirements and that Personas is especially useful in situations where it is eminent getting it right the first time.

6.5 Redundancy of Personas

Two respondents stated that Personas are unnecessary if user experience designers or expert users are part of the project team, meaning that the design decisions are not only left to the developers.

> R4: Personas are unnecessary when a design is not left to the developer but is in place long before the developers begin to create the software.

> R3: If you have an employee who is an expert user and knows what the user group need, Personas are unnecessary.

The Personas technique is considered redundant if User Experience Designers or similar is involved in the development process.

6.6 Weaknesses and Limitations of Personas

The respondents agreed that using Personas incorrectly can have a substantial negative impact on software or product development. They also agreed that Personas should not be used if there is insufficient data or if the creators are unfamiliar with Personas.

> R2: If the choice you make when creating the Personas is wrong it will work against the design.

Another respondent raised the concern that he felt constrained by some formalised Personas. Every time he was in doubt he went to look at the Persona, but this meant that he felt boxed in, and it stopped him from looking outside of the box.

> R3: When using Personas formalised you might be a bit constrained, always going to look at the posters with the Personas [...] To me it works better if I just keep them in my head. Of course, our company is not that large anyway so I can just talk to the developers if I need to change something.

Another respondent had drawn a similar conclusion:

> R1: What tends to go wrong in software development is that developers tend to lock on some user requirements pretty early in the process, without documentation, and then describe the entire solution. If the user requirements or the solution change at some point, the developers tend to forget the user and their needs somewhere in the process.

The respondents described using a technique like Personas could be a limitation in regards to the software developers, as the respondents could have a problem changing focus if the requirements changed at some point.

Using Personas requires a certain level of maturity. Another respondent's current organisation was not using Personas:

> R1: We are not using the Personas technique at the moment. I have worked with Personas in my last employment and found them very useful. I would like to introduce Personas in my current employment, but the company needs to be at a higher level of maturity before it would make sense. We simply have larger issues at the moment than this.

Using the Personas technique is described as a strength, but only if the company has reached a certain level of maturity. Personas are perceived as usable if the organisation is not mature.

6.7 Personas with Other Techniques

The respondents stated that scenarios are very usable in combination with Personas.

> R4: Scenarios are often used in combination with Personas.

Workshops and focus groups were also considered useful in combination with creating Personas.

> R3: We have a community around our product, and we host meetings with user groups, where we meet three times a year and discuss new releases and improvements.

Three respondents described that they are primarily using user stories to document the users' needs. The user stories are described by two respondents as being used instead of developing a specification of requirements.

> R3: We use common sense, and we are not afraid of making a mistake because it is okay if we do not get it right the first time.

Even though Personas are considered useful, the respondents also described working agile meaning that correcting errors was not perceived a big deal.

7 Discussion

In this section, we discuss our results about experiences about Personas reported in the literature, and we compare the findings across the two studies.

The discussion is structured with the following four issues:

1. software developers lack knowledge and understanding of their users, their work, and goals,
2. the Personas technique has been promoted as a strong tool for providing the software developers with a better understanding of the potential users,
3. the use of Personas has been a success, and
4. the Personas technique is not necessarily an incorporated part of the toolbox in the software development industry, and the industry might experience problems using Personas.

7.1 Lack of knowledge and understanding of the users

Software developers lack knowledge and understanding of their users and their needs (Bak et al., 2008; Bruun & Stage, 2012). In many development situations, users do not know what they want. Thus, it is the designer's job to find out. Pruitt and Grudin (2003) argue that good design does not come from users, but from designers. This is because users do not know what they want until they get it. But for this approach to work, the designers need in-depth knowledge of the users and their needs. Personas aim to provide that knowledge.

Among our findings was a poor application of the Personas technique in practice. This relates precisely to the point about developers lacking knowledge and understanding of the users, since the Personas descriptions, if applied, are made sparse and only used in a very narrow time frame of the development process. Another finding was that the development of the Personas lacked resources since none of our respondents had a budget allocated specifically for the Personas development. This is contrary to the related work emphasising that Personas can lead to better design decisions (Cooper, 2004; Pruitt & Adlin, 2010; Dotan et al., 2009; Long, 2009; Ma & LeRouge, 2007; Miaskiewicz & Kozar, 2011).

7.2 Personas can help developers understand users

The Personas technique has been promoted as a strong tool for providing software developers with a better understanding of the potential users (Cooper & Reimann, 2003). Thus, Personas is presented as a useful technique to keep the developers focused on the users and their needs and gave them empathy towards the Personas and the end-users (Cooper & Reimann, 2003; Nielsen, 2004).

The results from our questionnaire indicate that the most useful aspect of using the Personas technique was that Personas helped the team share a specific and consistent understanding of several, different user groups; which can lead to another advantage of product optimisation.

In our case study, we found that the respondents perceived Personas as a technique that supports designing and engineering interactive systems with a focus on the end-users. Matthews et al. (2012) found that mainly developers who have been working with Personas are positive in regards to a technique like Personas. We got the same impression from our respondents. Unfortunately, the Personas technique is still suffering from developers considering it unnecessary; e.g., one respondent explained that his colleague told him that creating background material or drawings was a waste of time.

7.3 Personas used as a successful tool

Several papers conclude the use of Personas has been a success (Cooper et al., 2007; Dotan et al., 2009). This corresponds with the experiences of our respondents who are using Personas. The tool is described as useful to help developers understand the users and their needs, especially if the system needs to be usable for several different types of end-users. Some respondents using Personas, identified some challenges for creating Personas, e.g., "it can be hard to find templates for creating Personas." another respondent stated that "it is a challenge to map all user groups without asking all customers". These obstacles have to be resolved before Personas can be applied as a useful tool.

In our case study, we found that the practitioners do not use Personas as suggested in the literature. Instead, data is collected before creating Personas, and it is mainly collected in their own or the customers' organisation, or Personas are created on the basis of real users.

Baird (2002) argued that Personas could be developed in a workshop while discovering requirements. One of our respondents described how they used Personas, and hosted meetings with their user group regularly. These meetings were also used to get to know their users and to help get an understanding of the customers' needs.

Personas are primarily considered useful if designers and developers are

not working closely together to ensure that the developers understand the intended users and use, or merely as a representation of a user if there is no onsite customer available.

Using Personas has also been described as being risky. If the Personas created are targeting a wrong user group, the software solution could end up being developed for the wrong users.

Scenarios and user-stories are considered useful in combination with Personas. In particular, user stories have been used to describe user situations and as a requirement specification.

7.4 Personas are not incorporated in the industry

The Personas technique is not necessarily an incorporated part of the toolbox in the software development industry, and the industry might have problems using Personas (Blomquist & Arvola, 2002). Since only 44% of our respondents have ever heard about the Personas technique and less than 12% have worked with creating Personas, it is fair to say that Personas are not an integrated tool in the software development industry in this region. Also, we found that only four respondents indicated that Personas should be used through the entire development process, meaning that even if Personas are used, they are not necessarily used to their full potential. In companies using Personas, the technique is used mainly to identify types of users or use cases.

The Personas are kept to a minimum and not focused on describing whole characters. As in the related work, we found developers lacking understanding of how to use Personas to gain most from their usage (Cooper & Reimann, 2003; Blomquist & Arvola, 2002; Pruitt & Grudin, 2003). The reasons for that could be a combination of several aspects. We found that resources are not allocated specifically for creating Personas, which corresponds with the area of usability in general (Bak et al., 2008; Pruitt & Grudin, 2003; Svanæs & Gulliksen, 2008).

The full potential of Persona usage does not seem to have caught on in the industry. Matthews et al. (2012) found a connection between, on the one hand, the perception of Personas and, on the other hand, to what extent the technique was used and, the amount of training the developers had had using Personas.

8 Conclusion and Future Work

This paper has reported from a combined questionnaire survey and case study of experiences with the creation and use of Personas in software development practice. There are still only a few studies of the actual use of

Personas in software development practice (Billestrup et al., 2014). The purpose of these studies was to identify both on the overall level and in detail how practitioners in the industry create and use Personas in their development processes.

In the questionnaire study, we explored to what extent Personas were used by software development companies in a defined geographical area and whether they used Personas as proposed in the literature. To accomplish this, we conducted a questionnaire survey with complete responses from 60 software development companies. The study showed that only 7 out of the 60 software development companies used Personas. The results of the questionnaire also uncovered four issues. Lack of knowledge of the technique as such and lack of resources both related to companies not using the Personas technique. Sparse or badly designed descriptions or not being part of the development process both related to a poor application, when using the technique.

Our findings are well linked to other studies described in the related work section. Yet our study contributes with a new angle by focusing on making a complete study within a limited geographical area we now have a pretty good idea about if the Personas technique is an integrated tool in software development in this geographical area. We have not been able to find related work that has done a similar study in another country. This means that this paper is the first paper assessing whether and how Personas are used for developing software in the industry.

The main limitation on our results is that we focussed on a defined geographical area. This was necessary to achieve a high level of coverage of all companies in that area. As future work, it would be interesting to learn more about the advantages of using Personas. This area still needs further studies even though some advantages have been identified in this paper. Also, it would be interesting to learn if companies that do not use Personas are using another tool instead. The number of respondents for the questionnaire survey can also be seen as a limitation.

We have presented results that are qualitative and based on four developers who have been interviewed in depth. The number of respondents is obviously a limitation of this study, yet only few software companies are using the Personas technique in their development process, so it is very challenging to find even a few respondents with experiences from using the Personas technique. Conducting a qualitative study means that the perspective of the interviewees is in focus. Conducting a study like this obviously requires that the interviewees are trustworthy and telling the truth from their perspective.

It would be interesting to conduct a more extensive series of interviews with practitioners about their use of Personas and study how that influence the quality of the systems they develop. Also, if there is a correlation between the type of company that uses Personas and the product being developed,

and if the use of Personas differs by type of software development company or product being developed, and if the use of Personas differs by the size of the company.

Acknowledgment We would like to thank the companies and their employees that participated in our questionnaire survey. We would also like to thank the Danish innovation network in Information Technologies, Infinit for providing partial financial support to the research.

References

Adlin, T., & Pruitt, J. (2010). *The essential Persona lifecycle: Your guide to building and using personas*. Morgan Kaufmann.

Baird, S. (2002). *Using personas to discover requirements.* `http://philarnold.co.uk/wp-content/uploads/2009/10/User-Personas.pdf`. (Last accessed 08-01-2018)

Bak, J. O., Nguyen, K., Risgaard, P., & Stage, J. (2008). Obstacles to usability evaluation in practice: a survey of software development organizations. In *Proceedings of the 5th Nordic conference on Human-Computer Interaction* (pp. 23–32). doi: 10.1145/1463160.1463164

Billestrup, J., Stage, J., Nielsen, L., & Hansen, K. S. (2014). Persona usage in software development: Advantages and obstacles. In *International Conference on Advances in Computer-Human Interaction.*

Blomquist, Å., & Arvola, M. (2002). Personas in action: ethnography in an interaction design team. In *Proceedings of the second Nordic conference on Human-computer interaction* (pp. 197–200). doi: 10.1145/572020.572044

Bruun, A., & Stage, J. (2012). Training software development practitioners in usability testing: an assessment acceptance and prioritization. In *Proceedings of the 24th Australian Computer-Human Interaction Conference* (pp. 52–60). doi: 10.1145/2414536.2414545

Chang, Y.-n., Lim, Y.-k., & Stolterman, E. (2008). Personas: from theory to practices. In *Proceedings of the 5th Nordic conference on Human-Computer Interaction* (pp. 439–442). doi: 10.1145/1463160.1463214

Chapman, C. N., & Milham, R. P. (2006). The personas' new clothes: methodological and practical arguments against a popular method. In *Proceedings of the human factors and ergonomics society annual meeting* (Vol. 50, pp. 634–636). doi: 10.1177/154193120605000503

Cooper, A. (2004). *The inmates are running the asylum: Why high-tech products drive us crazy and how to restore the sanity*. Sams.

Cooper, A., & Reimann, R. (2003). *About face 2.0: the essentials of interaction design.* Wiley, Indianapolis.

Cooper, A., Reimann, R., & Cronin, D. (2007). *About face 3: the essentials of interaction design*. John Wiley & Sons.

Corbin, J., & Strauss, A. (2008). Basics of qualitative research: Techniques and procedures for developing grounded theory. *Thousand Oaks*.

Dotan, A., Maiden, N., Lichtner, V., & Germanovich, L. (2009). Designing with only four people in mind?–a case study of using personas to redesign a work-integrated learning support system. *Human-Computer Interaction–INTERACT 2009*, 497–509.

Faily, S., & Flechais, I. (2011). Persona cases: a technique for grounding personas. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2267–2270). doi: 10.1145/1978942.1979274

Friess, E. (2012). Personas and decision making in the design process: an ethnographic case study. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1209–1218). doi: 10.1145/2207676.2208572

Kvale, S. (1997). *Interview. 7. oplag*. Hans Reitzels Forlag.

Levin, D. (2004). *Which personas are you targeting?* (5 Minute Whitepaper)

Long, F. (2009). Real or imaginary: The effectiveness of using personas in product design. In *Proceedings of the Irish Ergonomics Society annual conference* (Vol. 14, pp. 1–10).

Ma, J., & LeRouge, C. (2007). Introducing user profiles and personas into information systems development. *AMCIS 2007 Proceedings*, 237.

Matthews, T., Judge, T., & Whittaker, S. (2012). How do designers and user experience professionals actually perceive and use personas? In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1219–1228). doi: 10.1145/2207676.2208573

Miaskiewicz, T., & Kozar, K. A. (2011). Personas and user-centered design: How can personas benefit product design processes? *Design Studies*, *32*(5), 417–430. doi: 10.1016/j.destud.2011.03.003

Nielsen, L. (2003). A model for personas and scenarios creation. In *Human centred technology workshop 2003* (pp. 38–40).

Nielsen, L. (2004). *Engaging personas and narrative scenarios* (PhD Thesis). Copenhagen Business School.

Nielsen, L. (2012). *Personas — user focused design* (Vol. 15). Springer Science & Business Media.

Nielsen, L. (2013). Personas. *The Interaction Design Foundation. Aarhus, Denmark*. (`http://www.interaction-design.org/encyclopedia/personas.html`)

Nielsen, L., Nielsen, K. S., Stage, J., & Billestrup, J. (2013). Going global with personas. In *IFIP Conference on Human-Computer Interaction* (pp. 350–357). doi: 10.1007/978-3-642-40498-6_27

Pace, S. (2004). A grounded theory of the flow experiences of web users. *International journal of human-computer studies*, *60*(3), 327–363. doi: 10.1016/j.ijhcs.2003.08.005

Powell, S., Keenan, F., & McDaid, K. (2007). Enhancing agile requirements elicitation with personas. *IADIS International journal on computer science and information systems*, *2*(1), 82–95.

Pruitt, J., & Adlin, T. (2010). *The Persona lifecycle: keeping people in mind throughout product design*. Morgan Kaufmann.

Pruitt, J., & Grudin, J. (2003). Personas: practice and theory. In *Proceedings of the 2003 conference on designing for user experiences* (pp. 1–15). doi: 10.1145/997078.997089

Quesenbery, W. (2004). Using personas: Bringing users alive. *STC Usability SIG Newsletter-Usability Interface*.

Svanæs, D., & Gulliksen, J. (2008). Understanding the context of design: towards tactical user centered design. In *Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges* (pp. 353–362). doi: 10.1145/1463160.1463199

Turner, P., & Turner, S. (2011). Is stereotyping inevitable when designing with personas? *Design studies*, *32*(1), 30–44. doi: 10.1016/j.destud.2010.06.002

Urquhart, C. (2012). *Grounded theory for qualitative research: A practical guide*. Sage.

Urquhart, C., Lehmann, H., & Myers, M. D. (2010). Putting the 'theory' back into grounded theory: guidelines for grounded theory studies in information systems. *Information systems journal*, *20*(4), 357–381. doi: 10.1111/j.1365-2575.2009.00328.x

Contribution 3

UX Requirements to Public Systems for All: Formalisation or Innovation

Jane Billestrup, Anders Bruun and Jan Stage

The paper has been published in the
INTERACT 2015 Adjunct Proceedings: International Conference on Human-Computer Interaction, pp. 407–427, 2015.

The layout has been revised.

Abstract

Many countries are developing e-government applications for digitalisation of the interaction between citizens and government administrations. To be successful, such applications must be usable and provide a good user experience for all. In Denmark, e-government applications have traditionally been developed through a contract-based approach; but the experience has been quite negative, in particular in terms of user experience and innovation. To increase the user experience and provide a broader range of innovative solutions, the Danish government and the organisation of the municipalities have produced guidelines and material for a more user-centred development process for the ongoing digitalisation of local government services. We present the guidelines and material together with the findings from case studies in four IT companies, where we have interviewed employees and conducted redesign workshops. Our findings indicate that the material and guidelines are a step forward, but they are too general and have failed to ensure a reasonable level of usability and user experience.

1 Introduction

An increasing number of e-government applications are created to reduce or augment face-to-face contact between citizens and employees of municipalities. The success of such applications depends critically on usability and user experience. Empirical studies have found that if an e-government website has a high degree of usability, citizens are more likely to accept the website and keep using it (Clemmensen & Katre, 2012; Huang & Benyoucef, 2014).

Countries like the United States and the United Kingdom are considering the importance of usability when designing interfaces for e-government (Soufi & Maguire, 2007). Nevertheless, Wangpipatwong et al. found that e-government websites in several countries lack usability due to poor design and non-employment of user-centred design methodologies (Wangpipatwong, Chutimaskul, & Papasratorn, 2008). In South Africa, guidelines for designing e-government websites do exist but are generally not being applied by the web designers of the South African Provincial Government (Yetatziotis, 2008; Korsten & Bothma, 2005; Pretorius & Calitz, 2012). It is essential that citizens view e-government websites as both credible and reliable and have a high level of usability and user experience. One approach to accomplish that is to involve the end-users. The goal in applying user-centred design is that the system serves the user and that their needs influence the interface design (Norman, 1986).

The Danish municipalities are in the middle of a digitalisation process with the end-goal that by the end of 2015, 80% of the interaction between citizens and municipality employees, that was previously based on paper

forms will be handled digitally (Organisation of the Municipalities in Denmark, 2012). An example of these is an application for a new driver's license. Denmark has a population of 5.6 mio. people and is divided into 98 municipalities which serve as the single point of contact for citizens in regards to the public sector (The Danish ministry of health, 2015). The digitalisation effort in this domain is in line with the European Commission's initiative "Digital Agenda for Europe" that defines a set of actions for digitalisation of the European Union. Here, action number 64 is "Ensure the accessibility of public sector websites", and the aim is that the public sector websites for citizens should be fully accessible and usable for self-service by 2015 (European Commission, n.d.).

So far, development of e-government applications for Danish municipalities has generally employed a contract-based approach. With this, the development of a software system is based on a formal contract between a customer (usually a single municipality) and an IT company, where the contract includes a fixed specification of requirements to the application. The advantage of this approach is that there is little uncertainty about the application that will be delivered. However, there are numerous disadvantages, particularly for applications where the requirements are unclear or even changing over time. The contract-based approach typically involves the posting of formal bid material (or call for tenders) that IT companies use for making their proposals. Then the bids are assessed, a single IT company is selected, and a contract is signed. It has been argued that this approach implies that requirements that are not mentioned in the bid material and the contract are plainly ignored. The IT company that obtains the contract has no incentives to consider additional requirements that are not included in the contract; and often the contract has a very limited focus on user interaction, usability and user experience because these aspects appear to be difficult to specify.

This has led some to argue in favour of formal user experience requirements that can be objectively verified. The motivation for this workshop states that "This problem of omission or poor formalisation of UX requirements is limiting the success of projects in the public and private sectors."

It seems doubtful that a more formalised contract-based approach is viable because, in the e-government domain, the disadvantages of a contract-based approach are even greater than in the general case due to the nature of this domain (Skjetne, 2005). Development of e-government applications involves a broad array of different stakeholders, including citizens, public institutions such as municipalities, support organisations like an IT organisation that is servicing a group of municipalities, IT companies that produce applications and third-party purveyors that the public institutions use to provide services to the citizens. It has also been documented that user-centred design is particularly difficult to facilitate when a contract-based approach is employed for development of e-government applications. An important rea-

son is that some of the stakeholders are difficult to involve in a contract-based approach (Oostveen & van den Besselaar, 2005; Oppermann, 2005). The most important of these is the group of prospective users.

Even if stronger formalisation may resolve some of the problems originating from a limited focus on user experience, the lack of innovation will remain a key problem. When a contract is made between a single municipality and a single IT company, the individual municipality will not be able to choose between competing designs. Formalisation of requirements must be balanced against other factors, such as identifying user classes, introducing innovation, and ensuring consistency among products from the same IT company. For these reasons, the Danish government and the joint organisation of the municipalities in Denmark have decided on a different approach. A key aim is to make the design process more user-centred and to provide the municipalities with a range of e-government solutions developed by different IT companies (Kombit, 2014a).

This paper presents an empirical study of the user-centred approach that is being employed in the Danish digitalisation process. In the following section, we describe the material that has been developed to facilitate user-centred design in the development process and how the IT companies have been supported in their development of IT solutions. Then we present the method of our study of the IT companies. This is followed by a presentation of the findings of the study with a focus on the way the guidelines and material were perceived by the IT companies. In the conclusion, we discuss our findings and experiences in relation to similar work.

2 Guidance Material and Supporting Activities

Denmark is in the process of digitalising a significant amount of the services that municipalities provide to the citizens. The goal is that by the end of 2015, 80% of the forms that have previously been completed by citizens for the municipalities will be filled in and submitted digitally (Organisation of the Municipalities in Denmark, 2012). This strategy was set to be deployed in four waves. The first wave was deployed in December 2012 and the last wave in 2015. Each wave released a new set of digital applications. This study was conducted in 2013-14 focusing on the development of applications for the second wave. The plans for these four waves are shown in Table 3.1.

Before the outset of the process, the government and the joint IT organisation of the municipalities in Denmark decided to employ a new approach. Instead of the traditional development process based on a contract with a fixed set of requirements, the municipalities' joint IT organisation developed guidance and the following material to support a user-centred approach: a user journey, and 24 usability criteria.

	Public self-service applications area
Stage 1 2012	• Address change • National health service medical card • European health insurance card • Daycare • After-school care • School registration
Stage 2 2013	• Aid for burial • Free day care • Assistive technologies for handicapped or elderly • Exit visa • Unlisted name or address • Reporting of rats • Loan for real estate tax • Letting out facilities • Changing medical practitioner • Marriage certificate • Passport • Drivers' license
Stage 3 2014	• Garbage handling for citizens • Garbage handling for organisations • Construction work • Building permission • Loan for deposit • Registration in CPR • Services in roads and traffic areas • Notification of digging or work on pipelines • Certificates for Lodging • Parking permits
Stage 4 2015	• Personal supplement • Sickness benefits • Sickness supplement • Extended sickness supplement

Table 3.1: Phases of digitalisation of self-service areas in Danish municipalities (Kommunernes Landsforening, 2012).

The purpose of this material was to secure accessibility and keep a user-centred focus in the developed self-service applications. The joint IT organisation of the municipalities functioned in a supporting role during the development process. All interested IT companies could decide which specific services they wanted to develop. The services were produced and made available for all of the 98 municipalities in Denmark. The municipalities can buy individual solutions and are not bound by one self-service provider as they can choose freely between all developed applications in each area.

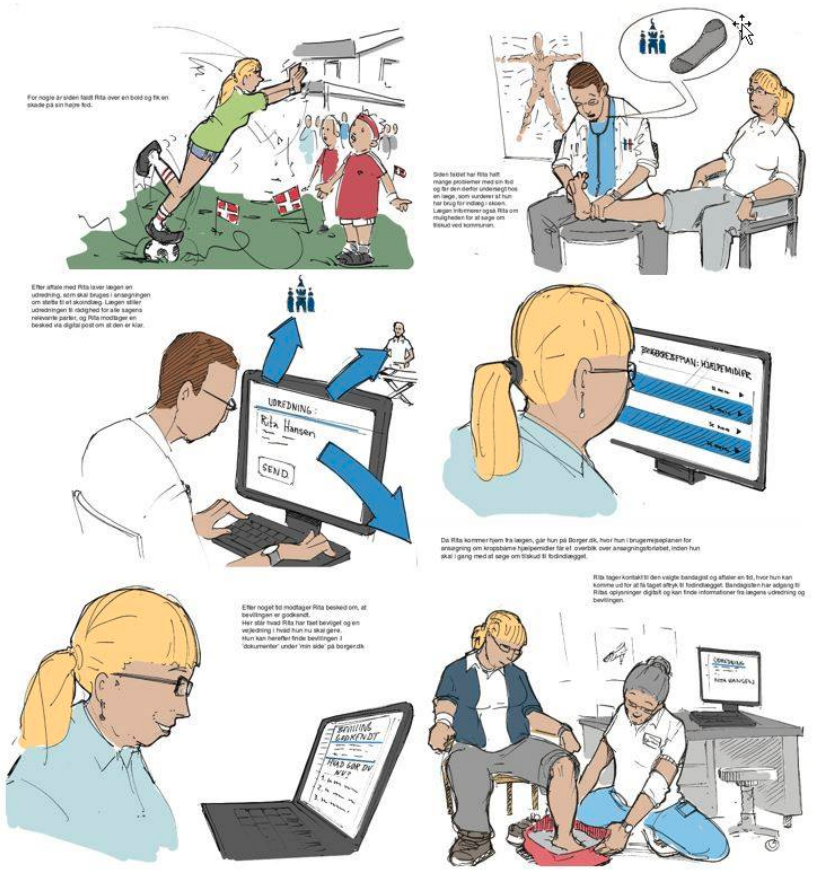

Figure 3.1: Selected drawings from the user journey for applying for assisting technology for handicapped or elderly (Kombit, 2014b). The short texts are in Danish and describe how Rita got injured some years ago. The doctor finds she needs an insole. Both interact with the system to apply for that. After approval, the insole is made.

2.1 User Journey

The user journeys can be described as a person in a use situation described in a scenario (Nielsen, 2004) using graphical illustrations. The user journey is a graphically illustrated story describing how a typical user will interact with the self-service solution. A user journey was created for each self-service solution in the second wave. The user journeys were made by the joint IT organisation of the Danish municipalities. The user journey for a specific self-service was made well before the IT providers would start developing that solution. The user journeys were developed on the basis of meetings in a focus group including both citizens and caseworkers at the municipalities. This was done to ensure that the user journeys would reflect an actual real use situation and the users' needs. Once the content was defined, the drawings were made by a professional artist.

The purpose of the user journey was to give both municipalities and the IT self-service providers an understanding of when and how users could interact with each system and to make sure that the end-users were kept in mind during the development process of the self-service solutions. A user journey was created for each of the specific self-service focus areas in the second wave. A total of ten different user journeys were developed. Six segments from a user journey can be seen in Figure 1 on the following page.

2.2 Usability Criteria

The usability criteria are a set of guidelines with the purpose of describing how the IT self-service providers could ensure that their applications were usable for all citizens. The criteria were defined at a 2011 IT and Tele Administration workshop focusing on usability (Kombit, 2011). It is stated that the criteria were defined by experts. The criteria were divided into four main focus areas, each consisting of six sub-categories. All 24 usability criteria are shown in Table 3.2.

2.3 Supporting Activities

The joint IT organisation of the municipalities has taken several approaches to supporting the self-service providers. They have hosted meetings and workshops where all the self-service providers were invited, and they have had meetings on a regular basis with each self-service provider. Additionally, the municipalities' joint IT organisation phoned the self-service providers on a regular basis asking for a status update and offering their help and services when needed.

Language and text

1. Texts are short and precise without containing legalese or technical terms
2. Text should be action-oriented and help the citizen
3. The citizen is informed of which documents to attach before filling out the form
4. The citizen can access additional information if needed
5. If an error is made it should be made very clear what is wrong
6. Error messages should be in Danish

Progress and flow

7. The form should be clear for the citizen
8. The extent of the form should be clear for the citizen
9. When filling out the form the citizen knows the progress made and how many steps are left
10. The receipt should be clear to see after finishing the form
11. The receipt should also be sent by email to the citizen
12. The next steps should be clear to the citizen after submitting

Data and information

13. If login is required, NemLogin (National Danish Identity Service) should be used
14. Excising data should be reused as much as possible so a citizen should not give the same information more than once.
15. A summary is shown before sending the form
16. Sending a form should only be possible if all required information is present
17. The solution should validate the typed information as much as possible
18. The solution should adapt as much as possible during the flow

Design and accessibility

19. It should be clear when filling out the form begins
20. There should be a clear distinction between positive and negative buttons, and the positioning should make sense
21. The authority behind the form should be clear
22. Navigating in the form can be done both using mouse and keyboard
23. The form can be filled out by the citizen without possessing special skills
24. The solution meet relevant accessibility criteria for self-service solutions

Table 3.2: The 24 Usability Criteria.

3 Method

This study was conducted as an empirical case study. The data was collected in 2013-2014. To get an overview of the development of self-service applications for the second wave, we initially interviewed one Project Manager from each of the 11 IT companies identified as developing self-service solutions for this wave (Billestrup & Stage, 2014). Thus the aim was to cover all 11 IT providers on an overall level.

Based on these initial interviews, we selected a self-service area and four IT-providers that we would focus on. As a self-service area, we chose an application for assistive technologies for handicapped and elderly; an example of this is an application for a hearing aid. As IT-providers, we chose, form the total pool of the 11 IT providers, four companies that were developing a self-service solution for this service area. We interviewed a total of 14 people working in these four organisations. In addition to the interviews, we had one half-day meeting and one workshop with each of the four IT companies. These activities aimed to study the development process of the solutions for this self-service area in more into detail.

3.1 Participants

Four IT companies participated in this study. The application for assistive technologies for the disabled or elderly was chosen because there were four self-service providers developing this solution which varied in maturity level. Two companies had an existing solution already in use by the municipalities that they were developing further, while the other two were new in this self-service area and were developing brand new solutions. The four organisations were divided as shown in Table 3.3.

	Immature organisation	**Mature organisation**
New self-service solution	Organisation A	Organisation B
Optimisation of existing self-service solution	Organisation C	Organisation D

Table 3.3: The IT companies chosen for this study.

The differentiation between mature and immature organisations was made in regards to developing self-service solutions. Of the new self-service providers, one was brand new in regards to self-service solutions. The other company was new in regards to the application for assistive technologies for the disabled or elderly but had developed several other self-service applications in

Denmark.

3.2 Preparations

When starting this study, we had one meeting with each of the four IT companies.

These meetings each lasted half a day. The project manager and the product owner were present, and in some of the IT companies, a developer and a user experience designer were present as well.

At the meetings, we were given a presentation of the development method used by the IT companies and how it was used in practice. We also received a demonstration of the self-service solution they were developing along with insights into how they worked with an on-site customer and their focus areas during the development process. At the end of the meeting we identified which people we wanted to interview as part of this study.

3.3 Procedure

To make certain all relevant people were interviewed for this study; we identified a set of relevant job functions that were perceived as important for the development process and which had extensive knowledge and different responsibilities regarding the development process, knowing that some people might possess more than one of these job functions. The identified job functions were the following: Project Manager, User Experience Designer, User Interface Designer, Product Owner, Software Developer, and Market Segment Analyst.

We conducted between two and four interviews in each IT company, totalling to 14 interviews.

Three months after the first meeting we had a redesign workshop with each IT company. In that period all interviews had been conducted and analysed. This meeting was conducted as a workshop in each company where the results from interviews were discussed, and focus areas were identified. The entire preliminary conclusion from the interviews was discussed, processed, and modified in the workshops.

3.4 Data Collection

As part of this study, four different methods were used for collecting data. We had one half-day meeting with each IT company. We conducted semi-structured qualitative interviews with two to four people involved in the development process of the self-service solutions from each company, We completed a content analysis of relevant documents from both the munic-

ipalities' joint IT organisations and companies, and we hosted a re-design workshop with each of the four companies.

All interviews were conducted as semi-structured qualitative interviews as described by Kvale (1997). The interviews lasted between 25 and 59 minutes each.

The interviews established clarity in regards to the following:

- the interviewee's job function and level of experience
- the development process, including strengths and weaknesses
- the view of the user journey and usability criteria, including its strengths and weaknesses
- establishing whether the user journey and usability criteria were usable for the self-service providers
- missing elements in the existing materials and ways to improve this

After all, interviews were conducted, the data were analysed regarding the different perspectives of each interviewee and their job function regarding the development process.

3.5 Data Analysis

Documents were gathered both from the municipalities' joint IT organisation and some of the IT companies. These were analysed, and the results were used in correlation with the interviews. The interviews were transcribed and both interviews and documents were analysed using Dedoose[1]. All findings were added to a list that became the topics for the workshop discussions. All workshops were recorded. After the workshops were conducted, the recordings were transcribed.

The results from this study emerged in two steps. After the interviews were analysed, a list of our findings was created. This list contained all statements regarding the strengths and weaknesses described in relation to the user journey, usability criteria and self-service providers' communication with the joint IT organisation of the municipalities.

These identified weaknesses were discussed at four workshops, one with each participating IT company. These workshops led to a set of guidelines describing how to make the existing material more user-centred and which focus areas were currently not addressed in the existing material or supporting activities.

[1] `http://www.dedoose.com`

4 Findings

First, we describe the findings from the conducted interviews, followed by suggestions for improving the user-centred approach.

4.1 Findings from the Interviews

Findings from the interviews are divided into three sub-sections describing perceived strengths and weaknesses of the user journeys, the usability criteria and the supporting activities. These findings identify the perceived strengths and weaknesses in regards to the development of the four self-service solutions and the companies' development process.

User-Centred Approach

The concept of involving User-Centred Design in the development process and creating user journeys was primarily described as a useful idea. The user journeys were generally described as neatly graphically created and helpful in regards to keeping the focus on the end-user when designing the e-government applications. On the other hand, none of the interviewees found the material to be a support in regards to developing self-service applications with a high degree of usability.

User Journeys

In regards to the user journey for application for assistive technologies for the disabled or elderly, it was primarily used by the IT self-service providers in preliminary meetings with the municipalities as a tool for aligning expectations between the self-service providers and the municipalities.

"The user journey has been a strong tool for opening the dialogue with the municipalities."

A few interviewees did describe some instances in which the user journey had set some expectations at the municipalities which the self-service providers then had to correct.

"Some municipalities thought we could deliver everything described in the user journey. They got quite disappointed when they realised we only deliver a small piece of the puzzle."

The purpose of the user journeys was not communicated well, as some interviewees described that both they and the municipalities found it unclear whether the user journeys were to be perceived as a set of requirements or as a vision of how the citizens were expected to be interacting with the municipalities in a near or far future.

Most interviewees found the user journey useless in their analysis of the target user group for two reasons. The first is because the user journey only described one of many possible use situations and the second because the user journey was released too late in the process for them to use it in their preliminary analysis of the target user group and system requirements.

Usability Criteria

The 24 usability criteria are described as a mix of technical requirements and guidelines such as what kind of language to use in the self-service solutions. Several interviewees described how the interpretation of the criteria has been difficult at times, and several interviewees found themselves interpreting the criteria differently than intended by the municipalities' joint IT organisation. Several interviewees stated that this slowed their development process as this wrongful interpretation was not discovered until a later time, causing them to have to go back and restructure to meet these requirements. This was described as frustrating, and several stated that they felt the usability criteria should have been described in more detail.

"I think they could have done a better job making the criteria understandable and user-friendly for the self-service providers."

Though this material was called usability criteria, the interviewees responsible for the usability and user-experience design of the developed self-service solutions felt that the usability criteria did not ensure that the self-service solutions would become usable for all citizens. The interviewees expressed opinions that the criteria lacked focus regarding actual use and usability.

Supporting Activities

Though most interviewees were positive regarding the support they received from the municipalities' joint IT organisation, they also found room for improvement, especially in regards to release of time schedules and the supporting material. The interviewees also mentioned that the joint IT organisation should put more effort into making sure that supporting solutions, such as a power of attorney, which should be implemented into the new solutions, were released on time. Several stated that they had a very tight deadline to develop and implement the self-service solution, but they were delayed because they had to wait for others to finish the specific parts the self-service providers were required to implement into their systems. The self-service providers felt that the joint IT organisation of the municipalities should put more focus into making sure these portions were finished on time.

During this study, we found several misunderstandings about the communication between the municipalities' joint IT organisation and the self-

service providers. For example, all self-service providers thought that the usability criteria were mandatory to implement, leaving them struggling to understand and implement these criteria into their solution, but we found later that the usability criteria were only intended as guidelines. Several times we had one understanding from all self-service providers, but later learned that the joint IT organisation of the municipalities had a very different understanding. For the user journey, we found that some self-service providers thought it was meant as a set of requirements that the developed self-service application had to meet, but the intention from the joint IT organisation of the municipalities was that the user journeys were meant as an inspiration to help keep the focus on the end-user.

Several interviewees described having trouble finding the documents or supporting materials they needed from the joint IT organisation of the municipalities. Even though the needed materials should be readily accessible on a website, several interviewees described that they had difficulty finding what they needed on this website. The website was mainly described as confusing, and the search function was not helpful in regards to this matter.

4.2 Suggestions for improvement

After the workshops, we created a set of guidelines for strengthening the focus on user-centred design and enhancing the communication between the municipalities' joint IT organisation and the self-service providers. These guidelines were based on the discussions from the workshops. Each workshop processed the same topics, but the workshop with the second self-service provider was also based on the results from the first workshop, and so forth. It would have been preferable to host a single workshop including all four self-service providers, but as they are competitors and based in different parts of the country, it was not a feasible solution. Overall, four foci areas were identified that needed to be optimised: Clearer communication, widening the focus to include all parts of the system, and not just the front-end, strengthen the involvement of all stakeholders, creating more user-centred material, and implementing a user-centred focus. These five focus areas will be elaborated in the following section.

Clearer Communication

Lack of communication has been an issue. This has been less of an issue in the day-to-day communication, but more problematic in communicating the purpose and intentions behind initiatives like the user journey and the usability criteria. The participants described feeling frustrated and confused from time to time. They also described employees at the municipalities feeling the same way.

It is important that the municipalities are part of the initiatives as they are the ones the joint IT organisation of the municipalities is representing. The caseworkers at the municipalities need to know the intentions behind the materials provided by the municipalities' joint IT organisation and how they will be able to use the materials to its full potential.

Widening the Focus

At the workshops, it was made clear by the participants that the process lacked a sense of the system as a whole. It was described that the focus was primarily on the citizens' solutions at the front-end, but that this should go hand in hand with prioritising the back-end as this will help optimise the flow of the whole process instead of creating two different systems that will de-optimise the work-flow.

As the focus is purely on the applications for the citizens, the system used by the caseworkers was not prioritised at all. Given that the aim was to save money in regards to the time that caseworkers use, this is a problem. Instead, the self-service solutions should be seen as one whole solution focusing on usability and efficiency in regards to both citizens and caseworkers.

Strengthen the Involvement of All Stakeholders

At the workshops, it was described as very important to involve all stakeholders before developing materials supporting user-centred design. Stakeholders were divided into four different categories: citizens, municipalities, third-party providers and IT providers.

Citizens should be represented by the target user group and involved to acquire an understanding of their needs and abilities. Some suggested involving societies such as those for the elderly or handicapped. Others were reluctant about this as they felt it was not ideal to involve societies that could set demands without having any responsibilities of their own.

Municipalities should be represented as their work-flows and procedures are very different. The caseworkers at the municipalities can also help with focusing on the correct group of end-users. The municipalities, as the purchasers of the IT solutions, need to be represented in the process as they are the ones who have to be able to use the materials to their full extent when buying the IT solutions.

Third party providers can be doctors, undertakers or surgical appliance makers. Some self-service forms are in all or most cases filled out by a third-party provider. For example, the application for acquiring aid for a funeral is always filled out by the Undertaker and not the relatives.

IT providers should be involved as they are the ones who will have to use the developed materials in practice. Involving them at an early stage will

give them an opportunity to comment and point out deficiencies at an early stage.

Creating More User-Centred Material

At the workshops, three important areas were identified: vision, clarification of user needs and technical requirements.

These areas are already present in the existing materials, but they are mixed as the user journey consists of both visions and user needs, and the usability criteria consist of user needs and technical requirements. We suggested that existing materials could be redesigned into three separate pieces.

The vision would describe which requirements could be set in the future and which goals the municipalities' joint IT organisation wish to achieve with the self-service solutions. The vision should be revised as requirements for technology changes but should always keep the focus on the interest of both the end-users and municipalities in regard to work-flow. By doing this, both municipalities and self-service providers would be able to understand what goals, existing solutions, updates and new solutions are important.

The clarification of user needs should describe several different types of users from the target user group and which special needs should be taken into consideration. This could be a collection of Personas as described by Nielsen (2012) and focus on special needs and requirements in relation to handicaps, nationality and age, depending on the target user group. This would give the self-service providers a thorough analysis of the end-users and their needs, and save the self-service providers time and effort. They all described not having time or funding for conducting a major user study themselves. If the joint IT organisation of the municipalities did this thoroughly, it would ensure all user segments would be taken into consideration during the development process of the self-service solutions.

The technical requirements should be created as a check-list targeted towards the software developers. This list should describe server response times and for which Internet browsers to optimise the software solutions. This would help the software developers to know exactly which technical requirements the self-service solutions had met, and it would provide the employees at the municipalities with a checklist they could use when deciding which self-service solution to acquire for each self-service area.

Implementing a User-Centred Focus

The above-suggested redesigns of the materials cannot stand alone in regard to acquiring a more user-centred approach both in regards to the citizens' usage and optimising the work-flow of the caseworkers. This needs to be supported by conducting usability evaluations on all self-service solutions in-

cluding the work environments of the caseworkers. These evaluations should be conducted by independent usability experts, so all self-service solutions are tested on the same basis. Then all IT solutions could be rated and benchmarked, or in other ways quantified, to make it clear for the municipalities whether or not an IT solution is user-centred and usable. This would ensure the self-service providers are focusing on creating usable systems. This recommendation was also suggested by several interviewees and discussed at the workshops.

Both a formative and a summative evaluation should be conducted. The formative evaluation should be conducted early in the process and could be conducted using a paper prototype, which would make it fairly inexpensive to change the design and fix problems very early in the design process.

All self-service solutions should be user-tested at the end of the process by conducting a usability evaluation with citizens from different user segments, and then benchmarked as described above. This would mean that all self-service providers would have to keep a user-centred focus during the development process, and it would help the municipalities to acquire usable self-service solutions without major usability problems.

5 Discussion

Previous research shows that usability and user-centred design are crucial for designing e-government services (Clemmensen & Katre, 2012; Huang & Benyoucef, 2014; Norman, 1986; Soufi & Maguire, 2007; Yetatziotis, 2008; Korsten & Bothma, 2005; Pretorius & Calitz, 2012; Wangpipatwong et al., 2008). Our study shows that implementing a user-centred approach is on the right track and the user-centred initiatives described in this study appear to be interesting and innovative. Nevertheless, the level of maturity is still low. In South Africa, guidelines for designing e-government websites have been created but are not being applied by the web designers of the South African Provincial Government (Yetatziotis, 2008; Korsten & Bothma, 2005; Pretorius & Calitz, 2012; Wangpipatwong et al., 2008). In this study, we found that wanting to implement user-centred design is not the same as actually creating a user-centred design. Creating and implementing tools such as a user-journey and usability criteria is a step in the right direction, but it takes time and more than one attempt to create materials like these that will actually improve the usability of the end-system.

Several researchers have argued that traditional methods for user-centred design are difficult or impossible to employ in the development of e-government applications. The arguments relate to the size of these projects (Oostveen & van den Besselaar, 2005) and the diversity of the user group (Oppermann, 2005).

A report from OECD on the European development of e-government services states very clearly that the focus on technology has for years overshadowed the need for organisational, structural, and cultural changes in the public sector. Therefore, key challenges and prerequisites for building attractive, integrated, user-focused e-government services have been left unaddressed (OECD, 2009).

This is in line with our findings where we have seen that some of the user groups have not been involved in the development of the IT services. Even though there has been a general interest in focusing on the users, citizens, in particular, the actual involvement has been very limited. It is interesting that this is emphasised consistently by several of the IT companies who argue that the citizens should be more directly involved.

Some researchers have presented ideas for overcoming the challenges of involving citizens in the development of e-government systems. One idea is to include citizens directly in groups or through representatives (Oppermann, 2005). Citizens were included by the joint IT organisation of the municipalities as various user groups were consulted when the user journeys and usability criteria were defined. However, our findings show that it has not been successful or sufficient.

Another possibility is to combine participatory methods with methods for technology assessment that have been tried in practice, although this requires a group that can drive these activities (Oostveen & van den Besselaar, 2005). So far, that has not been implemented in the Danish digitalisation project. It has also been suggested to use early prototypes as a means for verifying that the user requirements are correct (Skjetne, 2005). However, the viability of this idea has yet to be demonstrated in practice.

Iivari and Iivari examine user-centredness as a multidimensional concept along four aspects: as user focus, as work-centredness, as user participation, and as system personalisation (Iivari & Iivari, 2006). User focus reflects the traditional approach in user-centred design. Work focus is concerned with the work activities of the users. User participation is the active and direct involvement of the user. Finally, system personalisation indicates that the designed system can adapt or be adapted to the user during use. The Danish digitalisation project has aimed to achieve a strong user focus, although it has only been partly successful. The other three forms can be used as inspiration for further development. Unless there is a basic move in this direction, the intended degree of user take-up is unlikely to be realised (OECD, 2009).

Enhancing usability and designing with a user-centred focus is not only important in regards to the citizens. In Denmark, the strategy of digitalising citizens' self-services was conducted with the purpose of saving money. Bruun and Stage found that redesigning a citizens' self-service application for applying for a building project like a garage could decrease the time spent by the caseworker from an average of 53 minutes to 18.5 minutes (Bruun &

Stage, 2014). This shows that a user-centred focus is not only for the sake of the citizens but is a key aspect in regards to saving money on implementing E-government self-service solutions.

Focusing on both the front-end for the citizens and back-end for the caseworkers is important in regards to saving money on e-government self-service solutions. This means that it should also be a priority to develop a usable system in regards to the caseworkers. Another study has shown that a new system at a hospital for patient charts was not found to be more usable for the staff even after they had actually been using the system for a year than it was immediately after the system was deployed (Kjeldskov, Skov, & Stage, 2010). This means that usability problems do not go away just because employees are using a system daily. Thus caseworkers in the municipalities are spending more time than necessary on each e-government application, compared to a system that was designed with a focus on usability from the start.

6 Conclusion

We have presented findings from an empirical study of the approach that is being employed in the Danish digitalisation process as well as how it is viewed by the IT companies. We have focused on the materials that have been developed to facilitate user-centred design in the development process and how the IT companies have been supported in their development of e-government self-service solutions. Our findings show that supporting others in designing user-centred applications, while well-intended is not straightforward. Wanting to create materials to help others design user-centred materials need to be designed very thoroughly and there need to be an understanding of both the end-users and the IT companies that are meant to use the material. The designers of the user-centred material need to understand all aspects of the development process and the end-users' needs. This is a challenge and should not be taken lightly if designing user-centred material that others are supposed to use in regards to understanding and designing for a target user group. Key points are that the material designed to support the IT companies in designing user-centred is very general and fail to ensure a reasonable level of usability. Instead, we have suggested some areas that could be improved in regards to communication, which include focusing on the entire system and not just the user-interface in regards to the citizens, and involving more stakeholders in the creation process of user-centred materials. Additionally, we suggested new materials to develop regarding vision, clarification of user needs and technical requirements. We suggest that these initiatives are backed with conducting usability evaluations of all self-service solutions. The idea is that by conducting these usability evaluations, the self-

service providers have to keep focused on creating self-service solutions that are usable and without significant critical usability errors. If all self-service solutions are evaluated and benchmarked, it will make it much easier for the municipalities to choose the most usable solutions.

This paper is based on interviews and other qualitative methods that have been used to discover the opinions of four out of the eleven IT companies that were involved in the development of the digital services. We have selected them to reflect the variety of IT companies, but we cannot guarantee that they are entirely representative. The findings presented in this paper indicate avenues for future work. The most urgent is to evaluate the actual usability of the systems developed so far. It is also vital to experiment with techniques for involving citizens actively in a user-centred development process for e-government applications.

Acknowledgment We would like to thank the IT companies and employees that participated in our questionnaire survey and the Infinit network for supporting the research.

References

Billestrup, J., & Stage, J. (2014). E-government and the Digital Agenda for Europe: A study of the user involvement in the digitalisation of citizen services in Denmark. In *Proceedings of the International Conference of Design, User Experience, and Usability* (Vol. 8518, pp. 71–80).

Bruun, A., & Stage, J. (2014). *Supporting Diverse Users: Implementing Usability Improvements of an E-Government Data Entry Website.*

Clemmensen, T., & Katre, D. (2012). Adapting e-gov usability evaluation to cultural contexts. In *Usability in government systems* (pp. 331–344). Elsevier.

European Commission. (n.d.). `http://ec.europa.eu/digital-agenda/en/pillar-vi-enhancing-digital-literacy-skills-and-inclusion/action-64-ensure-accessibility-public`. (Last accessed 29-10-2013)

Huang, Z., & Benyoucef, M. (2014). Usability and credibility of e-government websites. *Government Information Quarterly*, *31*(4), 584–595.

Iivari, J., & Iivari, N. (2006). Varieties of user-centeredness. In *System Sciences, 2006. HICSS'06. Proceedings of the 39th Annual Hawaii International Conference on* (Vol. 8, pp. 176a–176a).

Kjeldskov, J., Skov, M. B., & Stage, J. (2010). A longitudinal study of usability in health care: Does time heal? *International Journal of Medical Informatics*, *79*(6), 135–143.

Kombit. (2011). *Criteria for usability in self-service solutions.* http://www.kl.dk/ImageVault/Images/id_56064/scope_0/ImageVaultHandler.aspx. (The government agency for digitalisation in Denmark, Last accessed 07-01-2018)

Kombit. (2014a). http://www.kombit.dk/indhold/leverand%C3%B8rer. (Last accessed 27-01-2014)

Kombit. (2014b, December). *User journey.* http://www.kl.dk/ImageVaultFiles/id_60480/cf_202/Illu.PDF. (Last accessed November 2016)

Kommunernes Landsforening. (2012, December). *Stage plan.* http://www.kl.dk/Om-KL/Opdateret-version-af-bolgeplanen-for-obligatorisk-digital-selvbetjening-id114939/?n=0&section=4652. (Last accessed 07-01-2018)

Korsten, H., & Bothma, T. J. D. (2005). Evaluating south african government web sites: methods, findings and recommendations (part 2). *South African journal of information management*, *7*(3).

Kvale, S. (1997). *Interview. 7. oplag*. Hans Reitzels Forlag.

Nielsen, L. (2004). *Engaging personas and narrative scenarios* (PhD Thesis). Copenhagen Business School.

Nielsen, L. (2012). *Personas — user focused design* (Vol. 15). Springer Science & Business Media.

Norman, D. A. (1986). Cognitive engineering. *User centered system design*, *31*, 61.

OECD. (2009). *OECD E-Government Studies Rethinking E-Government Services: User-Centred Approaches*. OECD Publishing.

Oostveen, A.-M., & van den Besselaar, P. (2005). User Involvement in Large-Scale eGovernment Projects: Finding an Effective Combination of Strategies and Methods. In *Proceedings of the INTERACT 2005 workshop on User Involvement in e-Government development projects.*

Oppermann, R. (2005). User participation supported by usability engineering experts in e-Government projects2. In *Proceedings of the INTERACT 2005 workshop on User Involvement in e-Government development projects* (p. 19).

Organisation of the Municipalities in Denmark. (2012, June). *Laws about mandatory digital self-service and digital mail has passed.* http://www.kl.dk/Administration-og-digitalisering/Lov-om-obligatorisk-digital-selvbetjening-og-digital-post-er-vedtaget-id105354/. (Last accessed January 2018)

Pretorius, M. C., & Calitz, A. P. (2012). The South African user experience maturity status for website design in provincial governments. In *Proceedings of the 12th European Conference on eGovernment, Institute of Public Governance and Management ESADE* (pp. 589–599).

Skjetne, J. H. (2005). Prototypes and tender documentation. In *Proceedings of the INTERACT 2005 workshop on User Involvement in e-Government development projects* (Vol. 1, pp. 69–74).

Soufi, B., & Maguire, M. (2007). Achieving Usability within e-Government web sites illustrated by a case study evaluation. In *Symposium on Human Interface and the Management of Information* (pp. 777–784).

The Danish ministry of health. (2015, January). *Reform of the municipalities.* `http://www.sum.dk/Aktuelt/Publikationer/Publikationer_IN/~/media/Filer-Publikationer-IN/Kommunalreformen/2005/Kommunalreformen-kort-fortalt/kommunalreformen-kort-fortalt.ashx`.

Wangpipatwong, S., Chutimaskul, W., & Papasratorn, B. (2008). Understanding Citizen's Continuance Intention to Use e-Government Website: a Composite View of Technology Acceptance Model and Computer Self-Efficacy. *Electronic Journal of e-Government*, *6*(1), 55–64.

Yetatziotis, A. (2008). *Impact of cultural context on web design for e-government in South Africa* (Master's thesis). Nelson Mandela Metropolitan University.

Contribution 4

Four Public Self-Service Applications: A Study of the Development Process, User Involvement and Usability in Danish Public Self-Service Applications

Jane Billestrup, Marta Larusdottir and Jan Stage

The paper has been published in the
International Journal on Advances in Software,
Vol. 9(3–4), pp. 333–345, 2016.

The layout has been revised.

Abstract

This paper presents a case study of four software companies in Denmark developing self-service applications for the same self-service area. This study outlines the process of how the four companies developed their self-service applications and a usability study of the completed software solutions. In this study, we have analysed the customer and end-user involvement and compared these results to the results of the usability evaluations. The main findings show that the usability varied in the four cases, and the ones who had the most customer involvement from caseworkers showed the highest number of usability problems in the self-service solutions for the citizens. We discuss the user-centred design approaches used, the drawbacks and benefits of customer and user involvement, and caseworkers acting as citizen representation during the development process of the software.

1 Introduction

This paper is an extended version of the paper "A case study of four IT companies developing usable public self-service solutions" (Billestrup, Stage, & Larusdottir, 2016).

European countries are currently developing digital self-service solutions for their citizens. These efforts are being launched to improve citizens' self-service and to reduce costs (European Commission, 2016). Though public self-service have been on the agenda in many countries for years, getting the end-users to use these applications is not easily achieved. For citizens to accept public digital services and websites, these sites need to have a high degree of usability for the citizens to accept the public digital services and websites (Clemmensen & Katre, 2012). Wangpipatwong et al. found that public digital websites in Thailand lack usability due to poor design and they recommend focusing more on the needs of the citizens to ensure that they will use these websites continuously (Wangpipatwong, Chutimaskul, & Papasratorn, 2008).

The Digital Economy and Society Index (DESI) describes the level of digitalisation of the countries in EU (European Commission, 2016). The digitalisation level is measured in five areas, connectivity, human capital, use of the Internet, integration of digital technology, and digital public services, respectively (European Commission, 2016). The level of digitalisation varies in the countries in EU, from Romania, Bulgaria and Greece at the bottom to Sweden, Finland, and Denmark at the top (European Commission, 2016). Denmark is one of the top 3 countries in regards to all digitalisation areas in EU and is one of the leading countries in the world in regards to the level of digitalisation (European Commission, 2016).

Denmark has a population of 5.6 million people and is divided into 98

municipalities as a single point of contact for citizens in regards to the public sector (The Danish ministry of health, 2015). In 2012, a digitalisation process was launched with the goal that by the end of 2015, 80% of all communication between citizens and the municipalities should be conducted digitally. This digitalisation also included digital public self-service applications (Organisation of the Municipalities in Denmark, 2012).

Until 2012, a contract based approach was used for developing digital public services, where the software companies competed by bidding. As of 2012, the software companies no longer had to put in a bid. Instead, they have to compete with other companies about selling their self-service applications to the municipalities. For the individual municipalities, it means that they can choose between competing designs for each digitalisation area for the citizen self-service applications.

To support the Danish initiative, the joint IT organisation of the municipalities in Denmark developed two sets of user centred guidance materials in 2012, to help the self-service providers in developing user-friendly self-service applications for the citizens (Kombit, 2014a). Similar initiatives have been taken in other countries like the United States, United Kingdom, and South Africa (Pretorius & Calitz, 2012; Soufi & Maguire, 2007; Huang & Benyoucef, 2014).

Development of self-service applications for all citizens involves a broad array of different stakeholders, including citizens, public institutions such as municipalities, support organisations like the joint IT organisation of the municipalities, IT companies that produce the applications and third party purveyors that the public institutions use to provide services to the citizens. In Denmark, the joint IT organisation of the municipalities has created guidelines to ensure that public digital self-service applications and websites are usable for all citizens (Organisation of the Municipalities in Denmark, 2012).

From the self-service providers' point of view, focus on usability will increase the price of the product, making the developed solution harder to sell (Jokela, Laine, & Nieminen, 2013). But studies show that the quality of the software and the cost are complementary, e.g., (Crosby, 1979; Harter, Krishnan, & Slaughter, 2000). To get public self-service providers to focus on usability, it has to be made a requirement. Both Jokela (2010) and Mastrangelo, Lanzilotti, Boscarol, and Ardito (2015) describe the importance of usability being specified in the requirements specification document. Mastrangelo et al. describes that public administration needs guidelines and guidance to get usability placed in the requirements to get the intended impact (Mastrangelo et al., 2015).

Jokela et al. found that to acquire usable digital self-service solutions the specified usability requirements have to be performance-based, as only these types of requirements would be verifiable, valid and comprehensive (Jokela et al., 2013). Additionally, the usability of digital self-service solutions should

be validated before the solutions are sold to the municipalities (Jokela et al., 2013).

According to Tarkkanen and Harkke, formal and detailed criteria for validation will cause usability workarounds by the self-service providers as they will focus only on the verification of their applications in regards to what is stated in the usability requirements, instead of focusing on getting the usability of the digital self-service solutions optimised and, finding and fixing usability issues (Tarkkanen & Harkke, 2015).

In this study, we have focused on analysing the development of public self-service applications, based on analysing each case based on the following four themes

- the development process used
- the customer involvement (caseworkers)
- the end-user focus (citizens)
- the characteristics of the products developed

These four themes were found by conducting a descriptive coding on all collected data as proposed by Saldaña (2015).

Additionally, we have analysed the number of usability problems found in each of the self-service solutions and compared it to the findings related to the four themes stated above.

In this paper, we have focused on analysing the customer and user involvement during the software development process. We discuss the user-centred design approaches used, the drawbacks and benefits of customer and user involvement found in these four cases, and describe the quality of each of the four self-service applications based on the analysis and the conducted usability evaluation.

Section 2 describes the background of this study. Section 3 presents the method of this case study. Section 4 presents the results. Section 5 provides the discussion, and finally, Section 6 presents the conclusion.

2 Background

In opposition to the traditional development process based on a set of requirements and a fixed contract, the joint IT organisation of the municipalities in Denmark decided on a new approach in 2012. According to the project manager at the joint IT organisation of the municipalities, the goal of conducting this change was to ensure that the developed self-service applications had a high degree of usability and that all relevant stakeholders were involved in the development process. The first wave was deployed in December 2012

and the last wave in 2015. Each wave released a new set of digital self-service applications. Table 4.1 shows the plan for the deployment of the four waves.

This study was conducted in 2013–14 mainly focusing on the development of one application for the second wave.

Since 2012 approximately 30 different public self-service application areas have been made mandatory for citizens to use. Across these self-service areas, around 100 different self-service applications have been sold to the municipalities from more than twenty self-service providers (Organisation of the Municipalities in Denmark, 2015).

The municipalities' joint IT organisation developed two sets of guidance materials supporting a user-centred approach in the development of public self-service applications (Kombit, 2014b, 2011). A User Journey and a set of 24 Usability Criteria, respectively.

The user journeys can be described as a person in a use situation described in a scenario (L. Nielsen, 2004) using graphical illustrations. An illustration showing six pictures from one user journey is presented in Figure 1. The usability criteria are a set of guidelines listing requirements for all developed self-service applications. An overview of the usability criteria for the development of public self-service applications can be seen in Table 4.2.

The overall purpose of these materials was to provide the IT self-service providers with tools to keep a focus on the citizens and their needs to ensure that the developed self-service applications were usable for all citizens. The joint IT organisation of the municipalities functioned in a supporting role during the development process. All interested IT companies could decide which specific services they wanted to develop. The services were developed and made available for all of the 98 municipalities in Denmark. The municipalities buy individual solutions and are not bound by one self-service provider but can choose freely between all developed solutions in each area.

3 Method

We have conducted an empirical study of four competing IT development companies implementing usable digital self-service solutions for the same application area. Next, the four cases are presented, and the data collection and analysis are described in more detail.

3.1 The Cases

Below, the four companies are described. The companies have developed similar solutions and are competitors regarding the 98 municipalities in Denmark who are the potential customers. The SME scale (small and medium scale enterprise) (European Commission, n.d.) has been used to categorise

	Public self-service applications area
Stage 1 2012	• Address change • National health service medical card • European health insurance card • Daycare • After-school care • School registration
Stage 2 2013	• Aid for burial • Free day care • Assistive technologies for handicapped or elderly • Exit visa • Unlisted name or address • Reporting of rats • Loan for real estate tax • Letting out facilities • Changing medical practitioner • Marriage certificate • Passport • Drivers' license
Stage 3 2014	• Garbage handling for citizens • Garbage handling for organisations • Construction work • Building permission • Loan for deposit • Registration in CPR • Services in roads and traffic areas • Notification of digging or work on pipelines • Certificates for Lodging • Parking permits
Stage 4 2015	• Personal supplement • Sickness benefits • Sickness supplement • Extended sickness supplement

Table 4.1: Plan for deployment of self-service applications (Organisation of the Municipalities in Denmark, 2015)

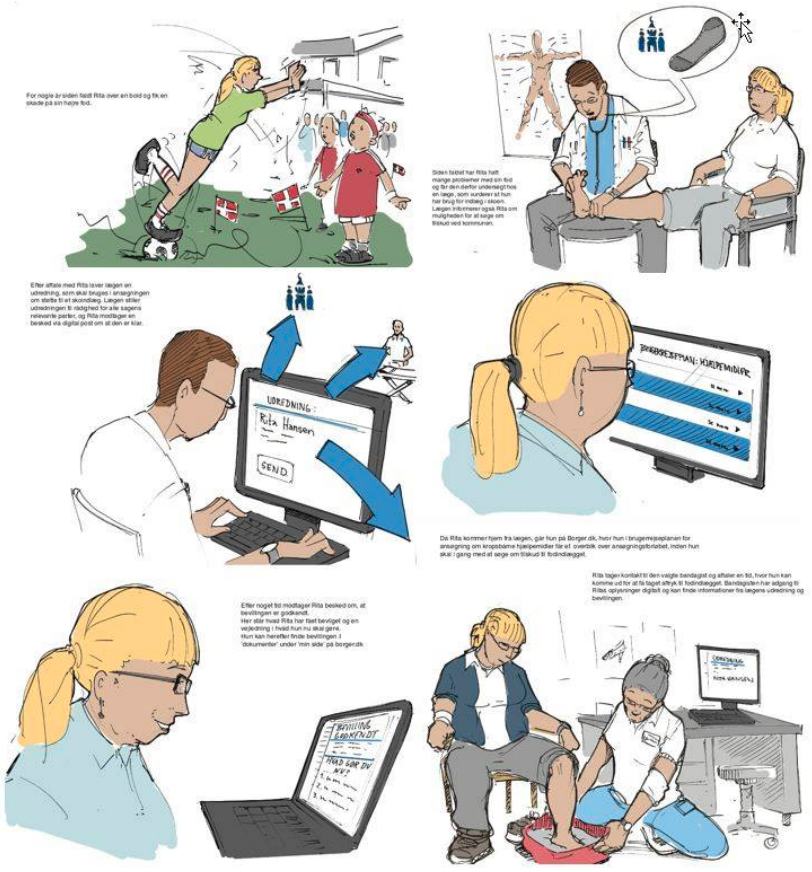

Figure 4.1: Six pictures from one user journey (Kombit, 2014b)

Language and text

1. Texts are short and precise without containing legalese or technical terms
2. Text should be action-oriented and help the citizen
3. The citizen is informed of which documents to attach before filling out the form
4. The citizen can access additional information if needed
5. If an error is made it should be made very clear what is wrong
6. Error messages should be in Danish

Progress and flow

7. The form should be clear for the citizen
8. The extent of the form should be clear for the citizen
9. When filling out the form the citizen knows the progress made and how many steps are left
10. The receipt should be clear to see after finishing the form
11. The receipt should also be sent by email to the citizen
12. The next steps should be clear to the citizen after submitting

Data and information

13. If login is required, NemLogin (National Danish Identity Service) should be used
14. Excising data should be reused as much as possible so a citizen should not give the same information more than once.
15. A summary is shown before sending the form
16. Sending a form should only be possible if all required information is present
17. The solution should validate the typed information as much as possible
18. The solution should adapt as much as possible during the flow

Design and accessibility

19. It should be clear when filling out the form begins
20. There should be a clear distinction between positive and negative buttons, and the positioning should make sense
21. The authority behind the form should be clear
22. Navigating in the form can be done both using mouse and keyboard
23. The form can be filled out by the citizen without possessing special skills
24. The solution meet relevant accessibility criteria for self-service solutions

Table 4.2: 24 usability criteria (Kombit, 2011)

Company category	Employees	Turnover	Balance sheet total
Medium-sized	< 250	$\leq$ € 50m	$\leq$ € 43m
Small	< 50	$\leq$ € 10m	$\leq$ € 10m
Micro	< 10	$\leq$ € 2m	$\leq$ € 2m

Table 4.3: SME Scale (European Commission, n.d.)

the size of the four companies involved in this case study, in regards to the number of employees and turnover. The SME scale is shown in Table 4.3.

The four companies were chosen because they were the only companies developing applications for this particular self-service area, and the companies and their developed self-service solutions were different in terms of maturity of the company and if the company was developing a new solution or was optimising an existing solution. The applications for this self-service area had some degree of complexity, and the self-service area would be relevant to all types of citizens, though mainly older citizens. Next, the four companies are categorised.

Case A is a micro/small company in regards to the SME scale and the turnover and number of employees. The company has not previously developed other public digital self-service solutions, so it is categorised as immature. Their digital self-service solution is categorised as new for the same reason. This company is an independent consulting and software company.

Case B is a large company in regards to the SME scale. The company is categorised as mature in regards to digital self-service solutions in general as they have developed several public digital self-service solutions previously. This self-service solution is categorised as new, though they already have an existing solution, as they redid both the analysis and design phase, before developing this solution. This company has departments all over Scandinavia and creates and sells software solutions to several different markets.

Case C is a large company on the SME scale. The company is described as both immature and mature in regards to digital self-service solutions, as they are experienced in regards to developing self-service applications. This area of application is relatively new to them, though having an existing solution in this self-service area. This company has departments all over Scandinavia and creates and sells software solutions to different markets. Case D is a large company on the SME scale. The company is described as mature in regards to digital self-service solutions and has developed digital self-service applications for years. For this self-service area, their self-service solution is an optimisation of an existing self-service application. This company is an independent consulting and software company. Table 4.4 shows the placement of the four cases in regards to maturity and if the digital self-service solution was new or an optimisation of an existing solution.

	Immature company	Mature company
New self-service application	Case A	
Optimisation of existing self-service application	Case C	Case B Case D

Table 4.4: Categorisation of the four companies and self-solutions in regards to maturity of the company and if the self-service solution is new or an optimisation.

We have defined the organisation's maturity according to their experience developing self-service applications in general. We defined the self-service application as new if the organisation had no existing self-service solution in this area or had an existing solution, but the problem area was re-analysed before redesigning the system. Otherwise, the self-service solution was defined as an optimisation of an existing self-service application.

The data used for this categorisation was collected from each of the companies by the conducted interviews described in the following section.

3.2 Data Collection

This section describes the process of the data collection. The first sub-section describes how we collected the data that was analysed to determine the scope of this study in regards to which self-service area to focus on, and which companies it would be relevant to include in the study. The second sub-section describes the data collection for this study, which is the results documented in this paper.

Exploratory Preparation

All data was gathered over a period of one year. Qualitative interviews were conducted by phone with project managers from 11 of 12 identified digital self-service providers for all self-service providers identified for the second wave at this time. The primary objective was to learn how self-service providers were accepting and using the user-centred materials and learn about each company and their development approach (Billestrup & Stage, 2014). Additional data was gathered on how the user-centred requirements were used, and how existing requirements were redesigned (Billestrup, Bruun, & Stage, 2015). All interviews were transcribed and analysed by cod-

ing, using Dedoose [1].

This analysis leads to narrowing the focus on one public self-service area with four identified self-service providers.

Gathering the Data

For this case study, we had one half-day meeting with each of the four companies. The people present at the first meeting had the following job titles; for case A; CEO, Project Manager, and Usability Expert. For case B; Product Owner. For case C, Business Developer and, Senior Manager. For case D; Chief Consultant and, Chief Product Owner. The agenda for these meetings was an introduction to this study including a discussion of their gain of participating, as we offered inputs on their self-service solution and conducting a usability evaluation at the end of the process. The results of these activities would be usable to improve the four companies self-service applications.

Before the meetings, we had identified the roles of the people we would like to interview, as these functions were named differently in each company and some people would have more than one of these roles. The identified roles were the following; project manager, developer, interface designer, and the person responsible for the user experience and usability of the public self-service application. These roles were chosen to ensure to get different views of the development process and end-product, in relation to the user focus and involvement.

After the introduction the interviewee presented his/her company overall and, more specifically, how the practitioners were developing this chosen self-service application, including describing the development process and method, collaboration with stakeholders and end-user involvement. The product owner or project manager also gave a demonstration of the self-service application in its current state and handed over relevant internal documents describing their development process and showing design documents. Lastly, it was discussed which people they suggested for further interviews in the next part of our study to ensure we would cover all perspectives. At the meetings, we conducted a list of people covering the following roles previously described. We interviewed 14 people distributed across the four companies.

The purpose of the interviews was to determine current practice at each of the four companies in regards to customer and citizen involvement, and how the end-users were taken into consideration during the design and development process. We found that interviewing people with different roles and responsibilities would provide us with more data on different perspectives and areas of expertise inside each company. All interviews were conducted

[1] `http://www.dedoose.com`

	Preparation meeting	Interviews	Workshop	Total amount of participants from each company
Case A	3	3	1	**3**
Case B	1	3 (2)	2	**3**
Case C	2	3 (2)	2	**3**
Case D	2	5 (3)	2 (1)	**6**
Total (in all)	**8**	**14**	**7**	**15**

Table 4.5: Number of participants from each company in each phase

as semi-structured qualitative interviews as described by Kvale (1997). The interviews were conducted by phone and transcribed afterwards.

Table 4.5 shows the number of people involved in this study, from each of the four companies.

The number of participants from each company is shown for all phases of this study. The number in () represents new people, who were not part of the previous step, e.g., case D had two people present at the preparation meeting, and five employees were interviewed. Of these five people, three were not present at the preparation meeting. At the workshop with case D, two people were present, of these two, one had not been present at the preparation meeting and was not interviewed.

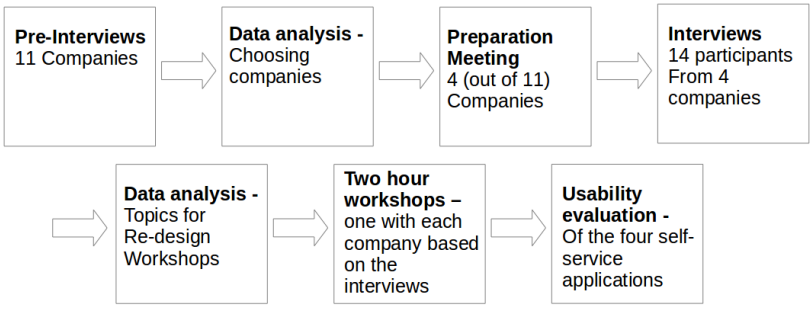

Figure 4.2: Shows the data collection process of the exploratory preparation and for this study.

The workshops were used to discuss the results from the interviews in regards to their user-centred approach and how the user-centred materials developed materials from the joint IT organisation of the municipalities were used during the development process, and to clarify our results from the

interviews and preparation meetings.

Usability Evaluation of Products

To evaluate if the development process had resulted in usable self-service applications for the citizens, a usability evaluation of these four self-service solutions was conducted. This evaluation was conducted as a think-aloud usability evaluation in a usability laboratory, with eight test persons. For the evaluations, all test persons received the same instructions explaining what they were meant to do during the evaluation, e.g., conduct a set of tasks and think aloud during the evaluation. All participants received the same tasks, and evaluated all four systems, but evaluated them in a different order to even out any bias.

The test persons were chosen to represent a user segment as large as possible. Our test persons ranged in age and had different educational backgrounds. The test persons varied in skill level and experience with computers, though all use the Internet on a regular basis. Most test persons had experience with other public digital self-service areas but not this specific area. An overview of the test persons can be found in Table 4.6.

All test persons received a small gift after participating in the evaluation. After conducting the evaluations, the data was analysed using the method Instant Data Analysis, as this method is also used on practitioners (IDA) (Kjeldskov, Skov, & Stage, 2004). The usability problems were categorised after the criteria described in Table 4.7. The problems were categorised in regards to levels of confusion and frustration of the participants, and whether they were able to fill out the forms correctly. These criteria and categorisations were described further by Skov and Stage (2005).

3.3 Data Analysis

The data was analysed with regard to the different perspectives of each interviewee and their job function to get an idea of what each company did during the development process.

The aim of these activities was to study the development process of the four companies developing the digital self-service solutions in this specific self-service area, into more detail. The cases were analysed exploratively.

We completed a content analysis of relevant documents from the companies. Both, interviews and documents were analysed using descriptive coding (Saldaña, 2015), and Dedoose [2] as a tool. All coding was conducted by one researcher and categories were discussed and verified by another researcher.

[2] `http://www.dedoose.com`

Test person	Gender	Age	Education	Experience with public services
TP1	F	44	High school degree (early retirement because of health issues)	Yes, also for this application type, and done digitally
TP2	F	31	PhD-student in Social science	Yes, for other service areas, and done digitally
TP3	M	52	Accountant	Yes, for other service areas, and done digitally
TP4	F	64	Retired school teacher	Yes, for other service areas, but not digitally
TP5	F	66	Technical Assistant	Yes, also for this service area, and done digitally
TP6	M	30	Msc. Engineering	Yes, for other service areas, and done digitally
TP7	M	65	Retired computer assistant	Yes, for other service areas, and done digitally
TP8	M	22	Bachelor student in computer science	No experience

Table 4.6: Overview of the demography of the test persons

	Slowed down	**Under-standing**	**Frustration or confusion**	**Test monitor**
Critical	Hindered in solving the task	Does not understand how the information in the system can be used for solving the task	Extensive level of frus-tration or confusion – can lead to a full stop	Receives substantial assistance, could not have solved the task without it
Serious	Delayed in solving the task	Does not under-stand how a specific functionality operates or is activated	Is clearly annoyed by something that cannot be done or remembered or something illogical that one must do	Receives a hint, and can solve the task afterwards
Cosmetic	Delayed slightly in solving the task	Do actions without be-ing able to explain why (you just have to do it)	Only small signs of frus-tration or confusion	Is asked a question that makes him come up with the solution

Table 4.7: Defining the Severity of the Usability Problems in the Digital Self-Service Solutions (Skov & Stage, 2005)

4 Results

In this section, we present our results. Our findings are divided into four subsections for each case, focusing on the development process, customer involvement, end-user focus and the final product, then the results are compared between the four cases for each focus area. All results are reported from the perspectives of the companies and their interviewed employees and the documents we got from them.

4.1 Case A

Development Process

Company A uses an agile development method and primarily in accordance with Scrum (Schwaber & Beedle, 2001). They describe their development process as flexible. "Our development method is agile, primarily Scrum. We use a pragmatic approach and a flexible model, meaning we can add features quite late in the process." They describe choosing this approach as it makes the development process easier and more dynamic, also, needing fewer people working on each project, e.g., they primarily have a project manager involved in the development process, who is also the designer and the developer. This is doable because they can make changes quite late in the process and they feel that correcting errors are not a big deal. "We are not afraid of making mistakes; we don't have a great need to get everything right the first time". One municipality was involved giving the company a greater understanding of the entire field of application.

Customer Involvement

The company collaborated with one municipality as a customer and stakeholder. It was insisted that the involved personnel should be caseworkers who understood their own and the citizens' needs and not necessarily people with IT skills. From the caseworkers, they have learned about the field of application. "We held a new workshop with the municipality every couple of weeks; here we created mock-ups that we used to design a new prototype, which was evaluated and redesigned at the next workshop, [...] until we were satisfied with the final prototype". The Interviewees were confident that they had developed a solution that lives up to the wishes and needs of their on-site customer but is less confident that their solution is covering the needs of other municipalities. "We have discussed if we should have created a standardised solution covering the needs of as many municipalities as possible." It was described as a problem as they were not aware of the fact that the interpretations of legislation are not the same in all municipalities.

End-User Focus

The citizens are not involved in the development process, but the company describes taking them into consideration by ensuring that the procedures for sending an application are as simple as possible. “We have created the solution so it should be understandable for all types of people. We have a good feeling here and our self-service application have been verified several times (by caseworkers)”. They have built an application that in the simple cases can send a decision back to the applicant right away without a caseworker having to go through the application first. One interviewee also described that their primary focus is on the customer and not the citizens. “We have been focusing on the customers’ needs and work procedures; it has been important for us to understand what they wanted the citizens to do”. This perspective was chosen because the municipalities are the paying customers and not the citizens.

Products

It was perceived as a strength that they have developed a “whole solution” covering both the necessities for the caseworkers and the citizens. “Our solution has a good flow for the citizens with understandable screen displays. It is not heavy on wording, and we only ask for information that is relevant for the municipalities to keep things as simple as possible.”

The company also identified some weaknesses in regards to their digital self-service application. They described that the fact that they only collaborated with one municipality might have been an issue, although they did not see it as a real option for them to have involved 3–5 municipalities in the development process. The company also recognises that there might be usability issues in the digital self-service application but argues that this is substantiated in what the municipalities are willing to pay for. “Reality is just different than theory. If you want to pay for it, you can get the great solutions focused on usability, but that is not what the municipalities want to pay for”. One interviewee described that if the customers do not care about usability they will not focus on that either.

4.2 Case B

Development Process

Company B uses Scrum (Schwaber & Beedle, 2001) as their development method, and they use an adjusted version of the project management method PRINCE2 (Bentley, 2010).

One interviewee described that the company develops one solution to fit all municipalities. “Our aim is to make one solution to fit all, [...] We only

create products were we keep the property rights [...], so we can sell the same product to several customers". All digital self-service applications are built in a module-based platform. This approach is chosen to give a certain amount of flexibility in regards to changing the design during the development process or when the system is tested by municipalities. Municipalities are involved early in the process.

Customer Involvement

The primary focus of the digital self-service application is on the back-end of the system, and to ease the workload of the caseworkers. "Our primary focus is to simplify the working procedures for the caseworkers. Otherwise, this would never be a priority for the municipalities". Before developing this solution, the company hosted workshops with five municipalities that are already customers, with the purpose of analysing the working procedures, used for creating a specification of requirements and a business case. "On the first workshop we are not presenting anything, typically we say – we don't know anything, tell us about your work [...] we use these workshops to learn how we digitally can support the digital workflow." This information is used in the development phase, where the first iteration is developed, and a prototype is created. The prototype was presented at the next workshop to caseworkers from the municipalities involved in the development process. The prototype shows the mapping when a citizen fills in a form and until it lands with the caseworker. One interviewee also described sending emails to all municipalities that are existing customers, asking the caseworkers to answer questions in regards to their workflow.

End-User Focus

The company does not involve citizens in the development process, but two interviewees described involving the municipalities and caseworkers as a representation of the citizens' needs. "The municipalities give us feedback in regards to what is not working for the citizens, e.g., parts of the application that citizens consistently fill out wrong". Though the focus is not directly on the citizens, it was stated by one interviewee that an optimisation of the back-end also brings value to the citizens as this will give a better flow with the handling of their applications. It was stated that focusing on accessibility of the system is more important than focusing on usability for the citizens.

Two interviewees did describe testing the application with users before launching the digital self-service application. "We have some pilot municipalities [...] they are part of a test phase where we assemble data for statistics". For the municipalities and caseworkers, the focus is on improving the efficiency of the workflows.

Products

The company perceives it as a strength of their digital self-service application that different kinds of professionals were involved in the development process. It was stated that the role of the product owner creates more value as he or she also has to ensure that the digital self-service application follows the legislations even if it changes. Two interviewees showed confidence in that they were ensuring to develop usable and intuitive digital self-service applications.

Late changes are described as being possible because the application is built in modules making changes less expensive. A perceived weakness is creating one solution to fit all needs. This approach was chosen as updating or testing would be too expensive if municipalities wanted something changed.

4.3 Case C

Development Process

Company C uses its own process, which is not a name given development method. "We use our own method which is built on several different methods. It also varies if we work agile, it depends on the project and the customers and if they wish to be and have the skills to be involved in the development process. In regards to the public self-service solutions, we are not working agile". The digital self-service applications are developed by the company without text and descriptions in the form the citizens are filling in. The municipalities have to write that information themselves. This approach was chosen to give the caseworkers at the municipalities the flexibility to get the information they think they need in a digital self-service application from their citizens and to be able to sell the same solution to all municipalities. The thought behind this is that all municipalities have different needs."There is a great difference between designing a solution for a large municipality or if it is a very small one. There is a great difference in usage and working procedures". One interviewee described that providing each municipality with the flexibility for adjusting as a key element in regards to the digital self-service applications they are developing.

Customer Involvement

The focus of the company is creating a solution that all municipalities can use. "It makes a very big difference if you are designing something for a large or small municipality. There is a very big difference in relation to how things are done or used." One interviewee described developing an application that fits all types of municipalities, by developing a blank form that the municipalities

can set up as they wish to get the citizens' to provide the information that each municipality finds important. This also means that each municipality buying this solution has to write all the text going into this digital self-service application.

Caseworkers at the municipalities are involved in the development process by a forum for the exchange of experience that the company is hosting for the municipalities that are existing customers. These workshops are hosted several times a year. "In regards to this specific solution we already have a solution that the citizens can access to fill out other applications or to get an overview of their own records, so this new application will be developed to be part of this existing system." Existing customers have been involved through these previously held workshops, but no customers are directly involved in the development of this digital self-service application.

End-User Focus

The company does not involve citizens in the development process. Two interviewees described creating a system that the municipalities can change to fit their needs. "We have structured it so the municipalities can make adjustments where and if they see fit, e.g., in regards to rewriting phrasings or functions that can be added or removed". The municipalities and caseworkers were involved before the design and development phase. The design and workflow were designed at workshops held before the redesign of this digital self-service application. The company focuses on usability by having usability specialists hired.

Products

It is perceived as a strength of their digital self-service application that they have developed a solution where the citizens can do everything in one place. "The citizens never leave their medical file when they need to fill in the self-service application". Two interviewees also perceive it as a strength that they have tried to cover all aspects of the needs that both citizens and caseworkers have.

A perceived weakness is that an interviewee feels they might not have spent enough time on usability when developing the digital self-service application for the citizens. "The self-service application might be kind of crude. People need to have prior knowledge to be able to use it." The interviewees also raised a concern about if less IT skilled citizens would be able to fill out the application.

4.4 Case D

Development Process

Company D use a staged development method but have implemented some agile techniques in the past years. They described involving customers as much as possible in the development process. "We use agile processes evolving around the customers. If we involve customers earlier in the process, we will learn earlier if there are processes we haven't understood". One interviewee did describe that this approach has been implemented in recent years and that the company earlier had the philosophy that they were the experts and not the customers.

The company have a department of User Experience Designers who are involved in designing and testing the front-end of the systems. Though they are isolated from the development teams and are mainly involved at the end of the development process by conducting summative usability evaluations.

The municipalities are involved several times during the development process, by conducting online meetings discussing prototypes. Two interviewees find this valuable as the company are developing one solution to fit all. The data collected from involving the municipalities are used for creating user-stories. "We always start by creating user-stories. [...] The user-stories are primarily used when the system has been developed". The company described using the user-stories to check if the developed system lives up to the needs specified in the user-stories.

Customer Involvement

The primary focus of this company is on the back-end of the digital self-service application. The company has involved municipalities by conducting a workshop with people from municipalities who are already customers. Representatives from six municipalities participated as on-site customers. The company hosted a workshop to learn about the number of applications and generating of ideas. At the end of this workshop, a specification of requirements was generated.

The caseworkers from the municipalities were involved several times during the development process but mainly through online meetings or email. This approach was chosen as a consideration for the employees. "Every time we have to pull the employees away from doing their regular job in the municipalities [...] Online meetings still gives them the ability to provide inputs. [...] Whenever we have a question we send an email asking if we are doing the right thing." One interviewee described that involving the customers during the development process is a relatively new procedure and that they now see this as best practice as it means they can do changes during the development process as changes late in the process are expensive and complicated.

End-User Focus

For this digital self-service solution, two interviewees described focusing on the citizens' needs and their flow through the application. "We know that this system is developed mainly for senior citizens, meaning that this system needs to be as simple as possible. This includes that all descriptions and wordings need to be easily understandable". One interviewee described that there had been a discussion about if they spent too much time on the citizen angle. "The end-user is not the one buying our product, it is the municipalities, [...] what matters is if they think our self-service solution is good". The digital self-service application is described as being part of a larger health care system, where citizens will have access to, e.g., former applications and the municipality will have everything in regards to one citizen in one record. For this digital self-service application, senior citizens without much experience with computers, have been involved in filling out a digital self-service application. In regards to the caseworkers and municipalities, they described focusing on full automatic digital self-service applications when possible.

Products

It was described as a perceived strength that they had integrated this application in their general healthcare record solution. "The citizens can see the full catalogue of the services the municipality offers and, after they have applied for something once, it is possible to make a reorder without starting over with the application." One interviewee described that they have simplified processes that otherwise might be difficult for less IT skilled citizens. For the caseworkers the solution is perceived as a strength in regards to, when an application ends up with the caseworker, the system has already validated that the citizens are entitled to what they have applied for.

It is perceived as both a strength and weakness that they always make applications that follow the legislation though some municipalities might have other requests. It is perceived as a weakness that they have been bound by an existing design on the general healthcare record solution. They feel this application might lack usability and that some written information might be too small for the application.

4.5 Summary of Results

Development Process

Case A and B describes using a module-based platform as this provides flexibility to make changes, also late in the development process. Case D tries to avoid late changes by involving the customers early in the process. The cases A, B, and D finds customer involvement to be a key element. Case C

only work agile and involve customers if they find it relevant. Case B, C, and D describe making one solution to fit all municipalities, though case C describes developing a solution that is flexible so the municipalities can set it up as they wish, in regards to getting the information each municipality needs from the citizens.

Customer Involvement

Cases A, B and D asked on-site customers to participate during both design and development process. Cases A and B held continuously design workshops, where case D held one at the beginning and later primarily had remote access to the involved municipalities. Case C gathered information from workshops before the design phase but had no customer involvement besides that. Cases B and D stated that they mainly focused on the back-end of the system to be used by the caseworkers. Cases B, C, and D all stated that they were aware of that the municipalities have different needs as it depends on the size of the municipality and their interpretation of legislation. Case A described that they learned eventually that the municipalities have different needs, though learning this quite late in the process.

End-User Involvement

Neither of the companies has citizens directly involved in the design or development process, although cases B and D described testing their developed public self-service application on citizens after the development has been completed. Cases A and D implemented automatic decisions when possible, benefiting for both citizens and caseworkers. Cases A, B, C, and D all described that focusing on the needs of the citizens has not been made a priority, only the needs of the municipalities as customers. Case D described that they needed to focus less on the citizens and more on the municipalities as customers.

Cases A and D have mainly focused on the target user-group in regards to keeping the design simple for the citizens. Case B focused primarily on the flow of the end-users in their solution, and case C has used usability specialists to check if the design was usable for the citizens.

Products

Cases A and D highlight simplified processes as strengths in regards to their public self-service applications. Cases B and D find the fact that they focus on developing applications that follow the legislation as a strength. Cases C and D both describe it as a strength that the self-service application is integrated into one healthcare solution for all public healthcare applications. Cases A, C,

and D believe that a weakness of the citizen-centred self-service applications is lacking usability. Usability has not been made a priority by the companies as it was not a priority for the municipalities.

The applications from Case C and to some extent Case D were significantly smaller and less complex than the applications developed by cases A and B, e.g., the application from case C was created as a paper application.

4.6 Usability of the self-service Solutions

In the previous sections, we have focused on how the four self-service applications have been developed and how it was ensured that these applications were usable for the citizens, and would save time for the caseworkers. In this section we look at the state of the finished self-service applications and whether these applications are usable for citizens.

Of the identified problems, 11 were found across all four digital public self-solutions. Among these general problems was a lack of understanding of the purpose and flow of the self-service solutions, problems with attaching files. Also, test persons getting annoyed or confused by not being able to understand helping texts and the descriptions of the rules and regulations of the application area, leading to test persons filling in the wrong information in the text fields. And, misunderstanding data fields, also leading to the test persons filling in the wrong information in the text fields. An overview of the usability problems is shown in Table 4.8.

	Company A	**Company B**	**Company C**	**Company D**
Critical	2	5	0	1
Serious	17	18	11	15
Cosmetic	17	14	6	13
Total	**36**	**37**	**17**	**29**

Table 4.8: Usability Problems in Each Digital Self-Service Solution

The self-service applications developed by case A and B were much more comprehensive than the applications develop by cases C and D. The self-service applications from cases C and D were both part of a larger healthcare system, meaning that less information had to be filled out manually by the participants. Especially the self-service application from case C was very simple compared to the self-service applications developed by cases A and B.

Two critical problems were found in the self-service application from case A. one was about test persons not understanding which information to put in where and ending up writing the wrong information at the wrong place. The other critical problem was about file attachment. The test persons expe-

rienced problems because the helping text was not optimised for the browser and when they tried following the written steps the test persons got confused and stopped as what they read did not match the options they had.

Five critical problems were found in the self-service application from case B. Examples of these problems could be in regards to file attachment, as the test persons do not realise when a file has been attached. Another problem is about test persons not understanding the search function and how to enter search parameters.

No critical problems were found in the self-service application from case C, and one critical problem was found in the public self-service application from case D. With this problem the test persons got into a full stop. They had to click a drop-down menu on the left side of the screen at all test persons experienced a lot of trouble trying to figure out what to do. Test persons mainly figured out what to do when they started clicking different menu options and then got the right one.

5 Discussion

In this section, the results are discussed. First, the results are discussed for each case, and then the user-centred approach is discussed.

5.1 Discussing the results for each case

For supporting the discussion of the results from each case, we have made an overview of the results from the four cases in Table 4.9.

Case A

In case A, the company is micro/small in the SME classification and considered immature, since this is the first time they developed public self-service applications. The product is classified as new since the company does not have other existing products to base this product on. Their product is module based, so it is easy to make changes quite quickly to the product if needed. Their key features are that they frequently collaborated with one municipality through workshops and evaluating prototypes gathering information on the needs and getting feedback from caseworkers (the customer), but not the citizens (the end-users). The result of the usability evaluation showed 36 usability problems, but only two serious problems.

The high number of usability problems could be because the development team has not gained experience in developing products for this kind of customers. Another issue could be that they only involved one single

Theme	Sub-theme	Case A	Case B	Case C	Case D
The cases	**Company size**	Micro/ small	Large	Large	Large
	Maturity	Immature	Mature	Immature/ mature	Mature
Develop-ment process	**Method**	Agile, Scrum	In phases, Scrum in development phase, Prince 2	In phases, own method	In phases, agile elements
	Team	Project manager mainly, CEO part of analysis and sales process	Product owner, allocating needed resources through the process	Project manager, allocating needed resources through the process	Project manager, allocating needed resources through the process
	Platform	Module based, easy to make changes	Module based, easy to make small changes	Part of health care system, changes can be costly	Part of health care system, changes can be costly
Customer involvement	**Focus area**	Case workers and their needs	Case workers and their workload	System fits needs of municipalities	If system is needed; customer's willingness to pay
	Involved municipalities	One	Around five	All existing customers	Six
	Involvement type	4–5 workshops, prototypes, customer involvement	Workshops, emails, prototypes, customer involvement	Workshop	Workshop, emails, online meetings
End-users	**Citizen representation**	Primarily case workers	Primarily case workers	Primarily case workers	Primarily case workers
	Goal	Decisions at once	Optimizing work flows	Flexibility to fit each municipality	Decisions at once
	Usability	Verified by case workers	Testing on citizens in pilot releases	Hired specialists	Testing on citizens; hired specialists
Product	**Perceived strengths**	Applications verified right away	Follows legislation	Part of healthcare system	Part of healthcare system; Applications verified right away; Follows legislation
	Perceived weaknesses	Lacking usability	One solution fit all	Lacking usability	Lacking usability
Usability problems	**Critical problems**	2	5	0	1
	Total number of problems	36	37	17	29

Table 4.9: An overview of the four companies in regards to the focus areas.

municipality in their process, though having 98 municipalities as potential customers.

The company focused on easing the work process of the caseworkers and therefore involved the caseworkers as much as possible in the development process. This was done under the assumption that the caseworkers understood the citizens and their needs, but the high number of usability problems indicate that this is not the case, which means that citizens have to be involved in the development process to represent themselves and their own needs.

Case B

In contrast, to case A, case B is a large company and mature in developing public self-service applications, though this application is classified as new. Their product is module based on making it easy to conduct changes quite quickly to the product if needed. In case B, the developers collaborated with five municipalities through workshops, prototypes and emails, but did not collaborate with the citizens, although testing was done with citizens in pilot releases. The self-service application from case B had 37 usability problems, which was the highest amount of usability problems found in each of the four self-service applications. This self-service application also had the highest number of critical usability problems. This is surprising since it is a large, mature company and collaborated with several municipalities. Like in case A, case B also developed a solution focused on making the caseworkers activities more efficient. The fact that case B collaborated with five municipalities and experienced approximately the same amount of usability problems in their self-service application indicate that it is not the number of municipalities, and caseworkers involved that makes a difference.

It also indicates that citizens should be involved in the development process, as stated in the previous section.

Case C

Case C is a large company developing a solution that is an optimisation of existing software. They are grouped as mature since they have been developing self-service applications, but also as immature since this area of application is new to them. They involved all existing customers while developing this solution but also hired specialists for gathering feedback on their solution. Their solution showed 17 usability problems, which was the lowest of the four evaluated self-service applications. None of the usability problems were critical problems. The reason could be the specialist's advice, and involvement made the solution usable. Another reason could be that the solution is more limited than the solution from case A and B as this application is part of

a larger healthcare system, meaning that much less information has to be put in when filling in this application. Also, it was decided to make the solution from case C very simple, with actually little support for the caseworkers, so they still had to do some activities manually. Where case A and B are trying to optimise workflows and activities, which also makes the self-service applications more complex for the citizens and raises the risk of usability problems than transforming paper applications into digital self-service applications.

Case D

Case D is also a large company developing a solution that is an optimisation of existing software. It is grouped as mature since the company has been developing public self-service applications for years. They involved six municipalities in the development, did some testing with citizens and hired specialists to give advice. Still, there were 29 usability problems found, but only one critical problem. This might be the biggest surprise in the results since this company is using user-centred design processes and is experienced. This system is part of a larger healthcare system, meaning that much less information has to be filled in when filling in this application. So the solution is rather limited, but still, contains many usability problems. In case D usability professionals are a bit isolated from the development team and are mostly involved in a summative evaluation at the end of the development. This approach could have resulted in higher number of usability problems in the solution than if the usability professionals had been more integrated into the development process. But this also indicate that it is not a matter of how many municipalities, caseworkers or usability specialist's that is involved in the development process, but it might make a difference if citizens are involved in the development process.

5.2 Discussing the User-Centred Approaches used

The Danish digitalisation effort has been launched to support the development process and provide each municipality with more digital self-service solutions to choose from, and enhancing usability in these solutions. For this purpose, two sets of guidance materials were created, a user journey and a set of 24 usability criteria, respectively. The aim was that this approach would facilitate competition between the self-service providers, resulting in better and more user-centred self-service applications for the citizens. All four companies involved the municipalities in the design process both in regards to the back-end of the system meant for the caseworkers and in regards to the self-service applications meant for the citizens. Two of the companies described involving citizens quite late in the process for testing of the features, either by going live in a few "pilot-municipalities" or conducting a

usability evaluation.

Though a user-centred approach has been taken, our results correspond with the findings of Wangpipatwong et al. who found that e-government websites are lacking usability due to poor design and non-employment of user-centred design methodologies (Kombit, 2014a). The reason for this is that the municipalities according to the companies are only focusing on this to a small extent and are not willing to pay more than the bare minimum. This shows a mismatch between what the joint IT organisation of the municipalities and the municipalities are trying to achieve. The public self-service providers are focusing on what the municipalities are willing to pay for and want the citizens to do and not taking the user-centred approach with a citizens' perspective unless this is being requested by the municipalities. If the user-centred approach should be a success, it is important to involve the municipalities as well. They need to understand that quality and cost are complementary (Crosby, 1979; Harter et al., 2000) and why usability needs to be a focus area and why a usable system will be a sound investment though it might be a bit more expensive to develop. Bruun and Stage have found that redesigning a digital self-service application focusing on usability, can reduce the amount of time the caseworker has to spend on each application, with more than 50% (Bruun & Stage, 2014).

Jokela et al. (2013) and Mastrangelo et al. (2015) describe the importance of usability being specified in the requirements. It is questionable whether this approach will be successful unless the municipalities learn the values of these requirements and get the understanding that focusing on usability will reduce cost over time. The municipalities have some responsibility in this whole process also. If they are demanding that their solutions are assisting caseworkers in doing their job digitally in a fast and easy process, the software companies have more motivation for focusing on usability. The companies will not focus much on usability unless the municipalities are demanding usable products.

As described in Section 4.6 we found 11 usability problems across self-service applications from different companies; this shows that self-service providers have problems understanding the end-users needs in general, though usability has been on the agenda for more than twenty years. If we compare the general problems we found with Nielsen's usability heuristics from 1995, we found that the self-service providers have violated three of these heuristics. Number 2, Match between the system and the real world. Number 6, Recognition rather than recall. And, number 10, Help and documentation (J. Nielsen, 1995). This lack of understanding shows that the self-service providers have trouble understanding the basics of usability theory, and even more trouble understanding the needs of the end-users in general.

5.3 Benefits and Drawbacks of Customer and User Involvement

This paper documents the development process of four different self-service solutions and shows the use of three different approaches to digitalise self-service applications.

One approach used by case A and B was having caseworkers from the municipalities as onsite customers to represent both their own and the citizen's needs. This lead to self-service solutions that tried to simplify the caseworkers work processes and thereby ease their workload.

The second approach used by case C was not having an onsite customer but involving the caseworkers before starting the development process. This lead to a self-service solution less focused on easing the workload of the caseworkers, and this self-service application was closer to being a simple digitalised version of the paper applications used in the past.

The third approach used by case D was not having a direct onsite customer but involving caseworkers when it was felt to be needed. This approach leads to a self-service solution that was simple in some aspects but also trying to solve some tasks to ease the workload of the caseworkers.

From a citizen's point of view, the self-service solution from case C would be the most usable of these four, with 17 documented usability problems. Where the self-service solutions from case D had 29 documented usability problems, and the self-service solutions from case A and B had 36 and 37 usability problems, respectively. But looking at this from a caseworkers point of view, the self-service solution from case C would not be the optimal choice as this will not in any way ease their work processes or workload. Though it can be an argument that neither does the self-service solutions from case A, B or D at this time, as citizens experiencing problems filling out, self-service applications will mean that they are making mistakes. These mistakes will have to be corrected by the caseworkers later in the process, as documented by Bruun and Stage (2014).

Both case A and B, and, partly case D all used caseworkers as onsite customers. Our results show that this approach is not sufficient when developing self-service solutions for the citizens, with the purpose of easing the workload of the caseworkers. The caseworkers simply do not understand the needs of the citizens to a degree where this approach would be sufficient. This means that to get an understanding of citizen's needs, citizen's have to be involved.

6 Conclusion

In this study, we focused on analysing the customer and user involvement during the software development process, and the characteristics of the four products developed, and the results of usability evaluations thereof. We have discussed user-centred design approaches used, the drawbacks and benefits of customer and user involvement found in these four cases.

Our results show that citizens were not involved in the development process and that caseworkers were expected to represent and understand the citizen's interests. We conclude that this approach has not been successful as our usability evaluation of the four self-service application showed 17–37 usability problems experienced by the test persons. Several problems were leading to a full stop or a high level of frustration for the test persons.

This leads us to conclude that caseworkers are not suitable for citizen's representation and if the goal is to ease the workload of the caseworkers, citizens have to be involved in the development process too.

We recognise that it is a limitation that four companies were involved, in regards to drawing conclusions in a broad term about the entire development process of self-service solutions. As future work, it would be interesting to learn the perspectives of the municipalities from themselves, and not only through the self-service providers. And if the focus was contrasted to more structured opinions coming from developers side. As future work, accessibility could also be a focus area.

Acknowledgment We would like to thank the four companies who participated in this study and the joint IT organisation of the municipalities. We would also like to thank Infinit, for supporting this research, and the test persons participating in the usability evaluations.

References

Bentley, C. (2010). *Prince2: a practical handbook*. Routledge.

Billestrup, J., Bruun, A., & Stage, J. (2015). UX requirements to public systems for all: Formalisation or innovation. In *Workshop on Formalizing UX Requirements, Proceedings of Interact* (pp. 407–427).

Billestrup, J., & Stage, J. (2014). E-government and the Digital Agenda for Europe: A study of the user involvement in the digitalisation of citizen services in Denmark. In *Proceedings of the International Conference of Design, User Experience, and Usability* (Vol. 8518, pp. 71–80).

Billestrup, J., Stage, J., & Larusdottir, M. (2016). A Case Study of Four IT Companies Developing Usable Public Digital Self-Service Solutions. In *The Ninth International Conference on Advances in Computer-Human Interactions (ACHI 2016) International Conference on Advances in Computer-Human Interaction* (pp. 307–314).

Bruun, A., & Stage, J. (2014). *Supporting Diverse Users: Implementing Usability Improvements of an E-Government Data Entry Website.*

Clemmensen, T., & Katre, D. (2012). Adapting e-gov usability evaluation to cultural contexts. In *Usability in government systems* (pp. 331–344). Elsevier.

Crosby, P. B. (1979). *Quality is free*. McGraw-Hill.

European Commission. (n.d.). *SME definition.* `http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm`. (Last accessed November, 2016)

European Commission. (2016). *DESI Index.* `https://ec.europa.eu/digital-agenda/en/scoreboard/`. (Last accessed 08-01-2018)

Harter, D. E., Krishnan, M. S., & Slaughter, S. A. (2000). Effects of process maturity on quality, cycle time, and effort in software product development. *Management Science*, *46*(4), 451–466.

Huang, Z., & Benyoucef, M. (2014). Usability and credibility of e-government websites. *Government Information Quarterly*, *31*(4), 584–595.

Jokela, T. (2010). Determining usability requirements into a call-for-tenders: a case study on the development of a healthcare system. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction* (pp. 256–265).

Jokela, T., Laine, J., & Nieminen, M. (2013). Usability in RFP's: The current practice and outline for the future. In *Proceedings of the International Conference on Human-Computer Interaction* (pp. 101–106).

Kjeldskov, J., Skov, M. B., & Stage, J. (2004). Instant data analysis: conducting usability evaluations in a day. In *Proceedings of the third Nordic conference on Human-Computer Interaction* (pp. 233–240).

Kombit. (2011). *Criteria for usability in self-service solutions.* `http://www.kl.dk/ImageVault/Images/id_56064/scope_0/ImageVaultHandler.aspx`. (The government agency for digitalisation in Denmark, Last accessed 07-01-2018)

Kombit. (2014a). `http://www.kombit.dk/indhold/leverand%C3%B8rer`. (Last accessed 27-01-2014)

Kombit. (2014b, December). *User journey.* http://www.kl.dk/ImageVaultFiles/id_60480/cf_202/Illu.PDF. (Last accessed November 2016)

Kvale, S. (1997). *Interview. 7. oplag*. Hans Reitzels Forlag.

Mastrangelo, S., Lanzilotti, R., Boscarol, M., & Ardito, C. (2015). Guidelines to specify hcd activities in the call for tender for public administration websites. In *Proceedings of INTERACT* (pp. 497–513).

Nielsen, J. (1995). *10 usability heuristics for user interface design.*

Nielsen, L. (2004). *Engaging personas and narrative scenarios* (PhD Thesis). Copenhagen Business School.

Organisation of the Municipalities in Denmark. (2012, June). *Laws about mandatory digital self-service and digital mail has passed.* http://www.kl.dk/Administration-og-digitalisering/Lov-om-obligatorisk-digital-selvbetjening-og-digital-post-er-vedtaget-id105354/. (Last accessed January 2018)

Organisation of the Municipalities in Denmark. (2015, November). *Afslutningsnotat: Effektiv digital selvbetjening 1.2.* http://www.kl.dk/ImageVaultFiles/id_76493/cf_202/Afslutning_af_Effektiv_digital_selvbetjening_1.PDF. (Last accessed 09-01-2018)

Pretorius, M. C., & Calitz, A. P. (2012). The South African user experience maturity status for website design in provincial governments. In *Proceedings of the 12th European Conference on eGovernment, Institute of Public Governance and Management ESADE* (pp. 589–599).

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Sage.

Schwaber, K., & Beedle, M. (2001). *Agile software development with scrum*. Prentice Hall.

Skov, M. B., & Stage, J. (2005). Supporting problem identification in usability evaluations. In *Proceedings of the 17th Australian conference on Computer-Human Interaction* (pp. 1–9).

Soufi, B., & Maguire, M. (2007). Achieving Usability within e-Government web sites illustrated by a case study evaluation. In *Symposium on Human Interface and the Management of Information* (pp. 777–784).

Tarkkanen, K., & Harkke, V. (2015). From usability workarounds to usability around work. In *Proceedings of INTERACT* (pp. 513–520).

The Danish ministry of health. (2015, January). *Reform of the municipalities.* http://www.sum.dk/Aktuelt/Publikationer/Publikationer_IN/~/media/Filer-Publikationer-IN/Kommunalreformen/2005/Kommunalreformen-kort-fortalt/kommunalreformen-kort-fortalt.ashx.

Wangpipatwong, S., Chutimaskul, W., & Papasratorn, B. (2008). Understanding Citizen's Continuance Intention to Use e-Government Website: a Composite View of Technology Acceptance Model and Computer Self-Efficacy. *Electronic Journal of e-Government*, *6*(1), 55–64.

Contribution 5

The Usability State of Nine Public Self-Service Applications in Denmark

Jane Billestrup, Jan Stage and Anders Bruun

The paper has been published in the
International Conference of Advances in Computer-Human Interaction,
pp. 265–270, 2017.

The layout has been revised.

Abstract

Empirical usability research has documented usability problems in public websites and self-service applications. This paper uses data from usability evaluations of nine Danish public self-service applications from six self-service areas by five different self-service providers, to examine similarities in the usability problems found across self-service applications. The study found that the types of usability problems are present across self-service applications, self-service areas, and self-service providers. However, it is also found that the total number of problems have decreased significantly in the self-service applications that were usability evaluated in 2016. In this paper, we have shown that though the amount of found usability problems is significantly lower, three types of usability problems were present in both old and new self-service applications. These general types were button placement, attaching of files, and meaning of concepts.

1 Introduction

European countries are currently developing digital self-service applications for their citizens. These efforts are being launched to improve citizens' services and to reduce costs (European Commission, 2016). The Digital Economy and Society Index (DESI) measures the level of digitalisation in EU countries. According to DESI, Denmark is one of the leading countries in regards to digitalisation (European Commission, 2016). In 2012, a digitalisation process was launched in Denmark, with the goal that by the end of 2015, 80% of all communication between citizens and the municipalities should be conducted digitally; this also included digital public self-service applications (Organisation of the Municipalities in Denmark, 2012). In this paper, applications and self-service applications refer to digital forms used for applying for e.g., a new passport, this activity was until recent times conducted on paper, but has been digitalised in recent years.

Having public self-service applications does not mean that citizens are necessarily willing to use these applications. The usage depends on whether citizens find these applications easy to use (Clemmensen & Katre, 2012) as poor design can prevent citizens from using these websites (Wangpipatwong, Chutimaskul, & Papasratorn, 2008).

In Denmark self-service applications are developed by different companies, and several companies are developing similar self-service applications and competing about selling their applications to the 98 municipalities. The citizens do not experience that the applications are developed by different self-service providers as all applications follow the same design style guide, though the content and layout vary between the different companies.

To support the Danish initiative, the joint IT organisation of the munici-

palities in Denmark (KOMBIT) developed two sets of user-centred guidance materials in 2012 and early 2013, to support self-service providers in developing user-friendly self-service applications (Billestrup, Bruun, & Stage, 2015). Similar initiatives have been taken in countries, such as the United States, the United Kingdom, and South Africa (Pretorius & Calitz, 2012; Soufi & Maguire, 2007).

In this paper, we analyse the usability problems found across self-service applications and self-service providers to find commonalities in the usability problems. The purpose was to ascertain if the usability of self-service applications has been improved and if there are general usability problems across self-service applications. The categories of usability problems identified here have previously been published. The purpose and the content of this paper differ from (Billestrup, Bornø, Bruun, & Stage, 2016).

In the following section, we present the method of collecting and analysing the data for this study, Section 3 describes the findings. Section 4 discusses these findings, and Section 5 presents the conclusion.

2 Method

For this study, we use lists of usability problems gathered from usability evaluations of nine Danish self-service applications developed by five self-service providers for six different self-service areas. These evaluations were conducted between 2010 and 2016 (Billestrup, Stage, & Larusdottir, 2016; Bruun, Jensen, Skov, & Stage, 2010; Jørgensen & Stentoft, 2016).

2.1 Case Companies

This study includes three of the largest and most experienced companies in regards to developing public self-service applications in Denmark, one medium sized experienced company, and one small company with little experience in developing public self-service applications. Table 5.1 shows the year the usability evaluations were conducted and the relation between companies and self-service applications.

Usability evaluations were conducted of nine different public self-service applications from five different self-service providers, in six different self-service areas. The table also shows that the applications were evaluated in four usability evaluations.

2.2 Self-Service Applications

This section provides a description of each self-service area included in this study.

Year of Evaluation	Tested Self-Service Solutions	No. of Test Persons	Company and Usability Problems	Total usability problems
2010	Building permits	10	Company E; 7/26/38 +4	75
2014	Assistive technologies	8	Company A; 2/17/17	36
			Company B; 5/18/14	37
			Company C; 0/11/6	17
			Company D; 1/15/13	29
2014	Marriage certificates	4	Company B; 1/3/2	6
2016	Address change	6	Company E; 2/3/0	5
	Rent subsidy		Company D; 1/3/3	7
	Medical practitioner		Company C; 2/4/0	6

Table 5.1: Shows the relation between companies and self-service applications and number of usability problems found

Building Permits (2010)

The self-service application for building permits is used
when citizens apply for conducting construction work where a building permit is needed, such as building a garage. The evaluated building application was a digitalised paper application developed by company E. The application was developed before the approach of user-centred design was introduced in the development of public self-service applications.

Assistive Technologies (2014)

The self-service application for procurement of assistive technologies is used if a citizen needs to apply for assistive technologies, such as a hearing aid. These applications were developed just after the introduction of user-centred design in public self-service applications by companies A, B, C and D.

Marriage Certificates (2014)

The self-service application for marriage certificates is filled out by citizen's wanting to get married either in a church or by having a registry-office wedding. This application was developed just after the introduction of user-centred design in public self-service applications by company B.

Address Change (2016)

The self-service application for an address change is used when citizens are moving to a new address. This application was developed more than two

years after the introduction of user-centred design in public self-service applications. This self-service application was developed by company E.

Rent Subsidy (2016)

The self-service application for rent subsidy is used if citizens have a low income and live in rented accommodation. This application was developed more than two years after the introduction of user-centred design in public self-service applications by company D.

Medical Practitioner (2016)

The self-service application for changing medical practitioner is used if a citizen wants to change to another medical practitioner. This application was developed more than two years after the introduction of user-centred design in public self-service applications by company C.

2.3 Usability Evaluations

All usability evaluations were conducted as think-aloud evaluations on a PC in a Chrome browser. The building application, assistive technology applications, and marriage certificate application were conducted in a usability laboratory. The applications of address change, rent subsidy and medical practitioner were conducted at a student café.

Test Persons

In regards to the number of test persons for each evaluation, we are aware that the correct number of test persons has been discussed extensively in the research community, e.g., (Caulton, 2001; Hwang & Salvendy, 2010; Law & Hvannberg, 2004; Nielsen, 1995; Schmettow, 2012). All usability evaluations in this study were conducted with between four and ten test persons. All test persons in each test received the same instructions and the same tasks. The tasks were scenario based and were tasks a user would typically complete in these systems.

For the building application, the evaluation was conducted in 2010 with ten test persons. All test persons were experienced in conducting "do-it-yourself" (DIY) work. Their DIY experiences varied; two had only painted their homes, and eight had either restored parts or all of their homes. Experience with filling out online forms for the municipality varied from none to a few times for eight of the participants. The two remaining participants were more experienced and had filled out forms for the municipality more than ten times.

For the procurement of assistive technologies, the evaluation was conducted in 2014 with eight test persons. The four different self-service applications in this self-service area were usability evaluated during the same usability evaluation, where the four applications were given to the users in a different order to even out bias. Seven participants had experience with filling out public applications, of these, three had experience with public self-service applications; of these three, two had experience with the public self-service application for assistive technologies.

For ordering of a marriage certificate, the evaluation was conducted in 2014 with four test persons. Three test persons had experience with public self-service applications, though neither with this particular application.

The three self-service applications for address change, rent subsidy, and changing medical practitioner were usability evaluated in one evaluation with the same test-persons in 2016 with six test persons. All users had filled out a self-service application for an address change in the past; four participants had used the self-service application for a rent subsidy and changing medical practitioner before this usability evaluation.

Data Analysis from Usability Evaluations

All data were analysed using the instant data analysis (IDA) method (Kjeldskov, Skov, & Stage, 2004) by researchers. All usability problems were categorised as either critical, serious or cosmetic, in regards to levels of confusion and frustration of the participants, and whether they were able to fill out the forms correctly (Molich, 2003).

Results of Usability Evaluations

All results were documented in a list describing and categorising each usability problem. At least two people took part in the characterisation of the problems. The lists of usability problems across all nine self-service applications consisted of a total of 218 usability problems (21 critical, 100 serious, 93 cosmetic, and four uncategorised problems); no usability problems were removed prior to the analysis. The distribution of the usability problems across self-service applications, self-service providers and severity can be found in Table 5.1. The +4 by company E in the building application means that there were four problems, where the severity was uncategorised as this categorisation required a deeper knowledge of the domain than the researchers had acquired; it was left to the case workers to conduct the classifications of these four usability problems.

2.4 Data Analysis

The usability problems were analysed using a descriptive coding as described by Saldaña (2015). All 218 problems found across the lists of usability problems were coded in regards to the character of the problem. The descriptive coding provided us with a list of three categories after removing all specific problems only found in one self-service application. Subsequently, all the problems in each category were discussed between two researchers to validate the categories and ascertain if the problems in each category were comparable across self-service applications and self-service providers. All problems not directly comparable were removed, leaving only the problems appearing across self-service applications. The three categories were named: button placement, attachment of files, and meaning of concepts.

3 Findings

In this section, we present the findings from the categories button placement, attachment of files, and meaning of concepts, respectively. We also compare the results of the usability evaluations between applications from each self-service provider.

3.1 Button Placement

Usability problems in relations to button placement were found in four of the six self-service areas. It was mainly the placement of the "next-button" that confused the test persons.

In the building application, the buttons were placed at the top of the application, which made the test persons overlook the buttons, as this placement made these buttons difficult for them to find. Similar problems were found in two assistive technology self-service applications. The "next" button was hidden until the test person scrolled down to the bottom of the page, in the self-service applications for address change, and changing medical practitioner. It was later discovered that the buttons were only hidden in some Internet browsers. Subsequently, four different browsers have been checked: Chrome, Firefox, Safari and Internet Explorer. In Chrome the "next" button was hidden, in Firefox the button was partly visible and in Internet Explorer and Safari, the button was fully visible. The only indication of hidden buttons was the scrollbar located on the left side, which some test persons missed.

3.2 Attachment of Files

In the applications for building permits, rent subsidy, and changing medical practitioner, some test persons did not understand how to attach a file. When

the test persons had chosen a file to attach, they did not understand that they then had to press the "attach" button to get the file attached. Instead, some test persons clicked the "next" button, which meant that the document did not get attached.

When trying to attach files, the test persons in both the building application and two of the assistive technologies applications had difficulties seeing that a file had been attached. When a test person experienced problems understanding how to attach a file they tried to follow the guidelines; however, these were constructed to be browser specific and did not match the actual flow in the Chrome browser used for the usability evaluations.

3.3 Meaning of Concepts

Meaning of concepts is used as a broad categorisation of problems in regards to what the users read in the applications. This category covers wording, and term users do not understand, consequences of a conducting a specific action, like clicking yes or no, and unclear use of language, meaning that users do not understand what is expected of them.

The test persons experienced problems understanding the wording and terms used in the applications for building permits and all four applications for assistive technologies. The test persons had insecurities about clicking yes or no, as the consequences of choosing one or the other were not clearly stated, e.g., the test persons had to decide whether the municipality was allowed access to their medical file, but neither an explanation as to why or the consequences of choosing no was stated if they chose not to allow access.

In one of the applications for assistive technologies, the test persons had to click either yes or no in a radio button to the question "Do you consent to this?" The wording confused the test persons as they became insecure about what "this" meant. In the marriage application, one section had to be filled out by both parties which confused the test persons as the wording made them believe both parties had to be present in the same room to do that, which was not the case. In the application for address change, several test persons did not understand when to use a power of attorney, or what to use it for.

4 Discussion

In this section, we discuss our findings, including a comparison of applications from one self-service provider, and usability problems across self-service providers and year of evaluations.

4.1 Comparison of Applications From One Self-service Provider

We only evaluated one self-service application from company A, and both evaluations of the self-service applications from company B was conducted in 2014, which means that neither of these would be interesting to compare. Self-service applications from company C and D were evaluated in 2014 and 2016, and self-service applications from company E were evaluated in 2010 and 2016. Next, we will compare the number of usability problems to the type of applications and describe the tendencies in regards to the design of self-service applications.

Company C

In 2014 the application for procurement of assistive technologies was usability evaluated. This evaluation provided 17 usability problems in total, of which none were categorised as critical, 11 were categorised as serious, and six were categorised as cosmetic problems. This application was developed as a digitalized paper application and was part of a larger healthcare system.

The application looked identical to a paper application citizens used to fill out by hand, both in terms of format and design. The application was developed to provide the basic information the caseworkers needed to handle the application and did not intend to ease the workload of the caseworkers or to make the application process easier for the citizens (Billestrup, Stage, & Larusdottir, 2016).

In 2016 their application for changing medical practitioner was evaluated. This usability evaluation showed six problems in total, of which two were critical, and four were serious, and none were cosmetic. The application from 2016 was developed as a wizard and not as a digitalized paper application.

A segment of the application from 2014 is shown in Figure 5.1 on the top, and the application from 2016 is shown at the bottom.

Company D

In 2014 the application for procurement of assistive technologies was usability evaluated. That evaluation provided 29 usability problems in total, of which one were categorised as critical, 15 were categorised as serious, and 13 were categorised as cosmetic problems. This application was developed as a digitalized paper application and was part of a larger healthcare system. In 2016 the application for rent subsidy was evaluated; this evaluation identified seven problems. Of these, one usability problems was categorised as critical, three as serious, and three was classified as cosmetic usability problems.

The application from 2016 was developed as a wizard and not as a digitalized paper application. Segments of both applications are shown in Fig-

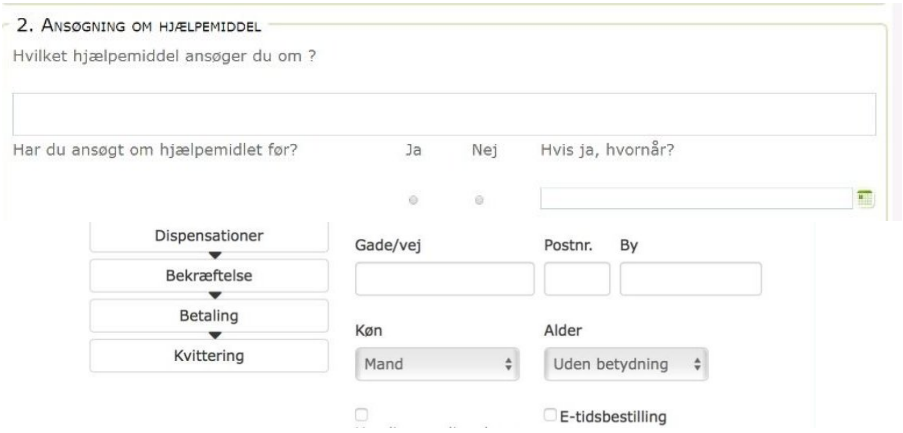

Figure 5.1: Shows parts of both applications from company C.

ure 5.2. The application from 2014 is shown at the top and the application from 2016 is shown at the bottom of Figure 5.2.

The application from 2014 is shown to the left, and the application from 2016 is shown to the right.

Company E

In 2010 the application for applying for a building permit was usability evaluated. That evaluation provided 75 usability problems in total, of which seven were categorised as critical, 26 were categorised as serious, and 28 were categorised as cosmetic problems. This application was developed as a digitalized paper application.

In 2016 the application for changing address was evaluated; this evaluation identified five problems. Of these two were critical, three were serious, and none were classified as cosmetic usability problems.

The application from 2016 was developed as a wizard and not as a digitalized paper application. Segments of both applications are shown in Figure 5.3.

The application from 2010 is shown on the top, and the application from 2016 is shown on the bottom of Figure 5.3.

Button Placement

In the building application, the “next” button was placed counter-intuitive to the test persons. However, most problems in regards to button placement

Figure 5.2: Shows parts of both applications from company D.

were present because the self-service applications were not optimised to different browser types.

Gemius Ranking logs Internet activity in Denmark to give access to statistical data about technology and Internet usage. According to Gemius, Chrome is the most used Internet browser on computers in Denmark (Gemius Rankings, 2016a). This indicates that a large amount of Danish citizens would experience hidden "next" buttons, which could lead to confused and annoyed citizens who might not be interested in using self-service applications(Clemmensen & Katre, 2012; Wangpipatwong et al., 2008).

Attachment of Files

Our results showed two types of problems in regards to file attachments. One type of problem was test persons not understanding how to attach a file; they pressed the "next" button instead of the "attach" button. Some tried to follow the guidelines in the self-service application. However, the guidelines were optimised for another browser, meaning that the steps did not fit.

A citizen experiencing these types of problems will likely lead to their inability to correctly attach a file. This means that they will either need to ask for help or send an application that might be incomplete. If they press the wrong button, they may not even be aware that their application is incomplete.

The other problem type is users not seeing when a file has been attached, which shows that the relevant information was either too small, or too much information was on the screen meaning that there was too little focus on the

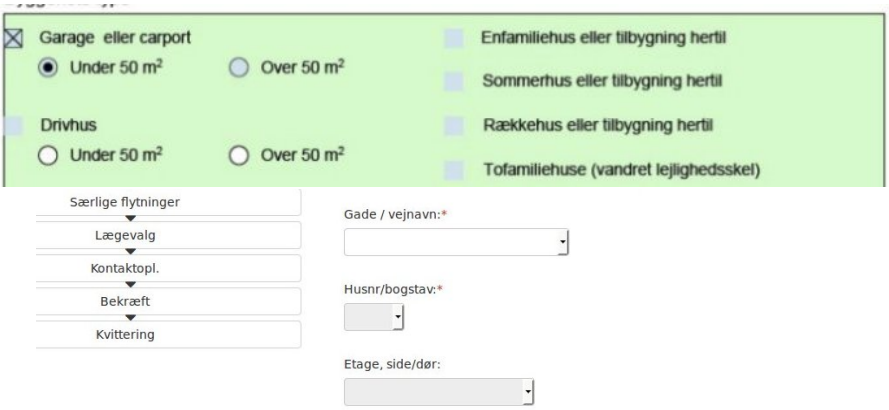

Figure 5.3: Shows parts of both applications from company E.

essentials, leading to users not noticing when a file had been attached.

Meaning of Concepts

Test persons experiencing problems with understanding meaning of concepts were found in all the evaluated self-service applications. The wording used was mainly directed at professionals or people with some amount of domain knowledge, and was not necessarily understandable for citizens. Or, the language was simply unclear. This problem made some test persons confused and afraid to make mistakes; as a result, some test persons stopped for a longer period, trying to figure out the consequences of choosing one option over the other. Several test persons stated that they would have given up and contacted the municipality by phone if this was not a test and they experienced this kind of doubt when filling out a public self-service application.

E. Usability Problems Across Self-Service Providers and Year of Evaluations

Table 5.2 shows a decrease of the numbers of found usability problems between 2014 and 2016 for company C and D, and between 2010 and 2016 for company E.

Billestrup, Stage, and Larusdottir found that the Danish self-service applications for procurement of assistive technologies, which were usability evaluated in 2014, were not developed with a user-centred approach, though this approach had officially been implemented as guidelines by the joint IT organisation of the municipalities during this period (Billestrup, Stage, & Larusdottir, 2016).

As the number of found usability problems have dropped significantly between the evaluations conducted in 2010 and 2014 to the ones conducted

Company	Year	Critical	Serious	Cosmetic	Uncate-gorised	Total usability problems
Company C	2014	0	11	6		17
	2016	2	4			6
Company D	2014	1	15	13		29
	2016	1	3	3		7
Company E	2010	7	26	38	4	75
	2016	2	3	0		5

Table 5.2: Shows the number of found usability problems from each self-service provider and usability evaluation.

in 2016, this indicates that some improvements have been made; this could indicate that a more user-centred approach has been enforced by companies during this period or simply that the evaluated applications from 2016 have been developed as wizards, designed to help the users. Also. In 2014 it was decided that all new public self-service applications should be usability evaluated which itself also could have had an impact (Kommunernes Landsforening, 2016) as usability evaluations might have caught some issues before the citizens had to use these applications. A decreasing number of usability problems could also indicate that citizens have increased their understanding of using public self-service applications over the past few years.

5 Conclusion

In this paper, we analysed the usability problems across self-service applications and self-service providers. The purpose of this study was to gain a greater understanding of the broader usability issues in public self-service applications. Our results show three types of usability problems found across self-service applications and self-service providers.

We have shown that public self-service applications need to be optimised for different browsers as this otherwise can lead to usability problems for the users. This should also include optimisation for different technologies such as tablets and smartphones, as Gemius rankings show that 56% of Internet usage in Denmark is not conducted from a computer but other devices, e.g., smartphones and tablets (Gemius Rankings, 2016b).

The first evaluation was conducted in 2010, two years before the user-centred design approach was implemented in the development of public self-service applications in Denmark. In 2012 the user-centred design approach was implemented, meaning that the system's usability was evaluated in 2014 and 2016 were evaluated after the introduction of a user-centred focus.

Though Billestrup et al. found that this was not the case in with self-service applications developed in 2014 (Billestrup, Stage, & Larusdottir, 2016).

This study showed that the number of problems has decreased since the introduction of the user-centred design approach, and we have shown an indication of more usable self-service applications, as the number of usability problems was significantly lower in 2016. However, we have also shown that though the amount of found usability problems was significantly lower, three types of usability problems were present in both old and new self-service applications.

This means that the approach taken by focusing on a user-centred approach, using wizards, and conducting usability evaluations has not been sufficient in eliminating some general and reoccurring usability problems found across self-service applications, self-service providers and self-service areas.

5.1 Limitations and Future Work

This study is limited to a single country by its focus on the Danish self-service applications and problems found across these self-service applications. As for future work, it would be interesting to compare our findings to similar studies from other countries.

Another limitation is that the lists of usability problems we have analysed for this study did not state how many test persons experienced each of the listed problems.

We are aware that many unknown factors could implicate the changes in the self-service applications besides the companies using a more user-centred development approach these unknown factors should be investigated further.

References

Billestrup, J., Bornø, N., Bruun, A., & Stage, J. (2016). Usability problems found across public self-service applications and self-service providers. In *Proceedings of the 28th Australian Conference on Computer-Human Interaction* (pp. 623–625).

Billestrup, J., Bruun, A., & Stage, J. (2015). UX requirements to public systems for all: Formalisation or innovation. In *Workshop on Formalizing UX Requirements, Proceedings of Interact* (pp. 407–427).

Billestrup, J., Stage, J., & Larusdottir, M. (2016). A Case Study of Four IT Companies Developing Usable Public Digital Self-Service Solutions. In *The Ninth International Conference on Advances in Computer-Human Interactions*

(ACHI 2016) International Conference on Advances in Computer-Human Interaction (pp. 307–314).

Bruun, A., Jensen, J. J., Skov, M., & Stage, J. (2010). *Usability evaluation of an electronic building application.* White paper.

Caulton, D. A. (2001). Relaxing the homogeneity assumption in usability testing. *Behaviour & Information Technology*, *20*(1), 1–7.

Clemmensen, T., & Katre, D. (2012). Adapting e-gov usability evaluation to cultural contexts. In *Usability in government systems* (pp. 331–344). Elsevier.

European Commission. (2016). *DESI Index.* `https://ec.europa.eu/digital-agenda/en/scoreboard/`. (Last accessed 08-01-2018)

Gemius Rankings. (2016a). *Browsers.* `http://rankings.dk/en/rankings/web-browsersgroups.html`. (Last accessed January, 2017)

Gemius Rankings. (2016b). *Devices.* `http://rankings.dk/en/rankings/pc-vs-nonpc.html`. (Last accessed January, 2017)

Hwang, W., & Salvendy, G. (2010). Number of people required for usability evaluation: the 10±2 rule. *Communications of the ACM*, *53*(5), 130–133.

Jørgensen, K., & Stentoft, M. L. (2016). *Usability analysis of public self-service applications.* Student report.

Kjeldskov, J., Skov, M. B., & Stage, J. (2004). Instant data analysis: conducting usability evaluations in a day. In *Proceedings of the third Nordic conference on Human-Computer Interaction* (pp. 233–240).

Kommunernes Landsforening. (2016). *User evaluation of public self-service evaluations.* `http://www.kl.dk/Administration-og-digitalisering/Brugertest-bidrager-til-oget-brugervenlighed-id211070/`. (Last accessed January, 2017)

Law, E. L.-C., & Hvannberg, E. T. (2004). Analysis of combinatorial user effect in international usability tests. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 9–16).

Molich, R. (2003). User-friendly web design. *Ingeniøren Books, Copenhagen*.

Nielsen, J. (1995). *10 usability heuristics for user interface design.*

Organisation of the Municipalities in Denmark. (2012, June). *Laws about mandatory digital self-service and digital mail has passed.* `http://www.kl.dk/Administration-og-digitalisering/Lov-om-obligatorisk-digital-selvbetjening-og-digital-post-er-vedtaget-id105354/`. (Last accessed January 2018)

Pretorius, M. C., & Calitz, A. P. (2012). The South African user experience maturity status for website design in provincial governments. In *Proceedings of the 12th European Conference on eGovernment, Institute of Public Governance and Management ESADE* (pp. 589–599).

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Sage.

Schmettow, M. (2012). Sample size in usability studies. *Communications of the ACM*, *55*(4), 64–70.

Soufi, B., & Maguire, M. (2007). Achieving Usability within e-Government web sites illustrated by a case study evaluation. In *Symposium on Human Interface and the Management of Information* (pp. 777–784).

Wangpipatwong, S., Chutimaskul, W., & Papasratorn, B. (2008). Understanding Citizen's Continuance Intention to Use e-Government Website: a Composite View of Technology Acceptance Model and Computer Self-Efficacy. *Electronic Journal of e-Government*, *6*(1), 55–64.

Contribution 6

Usability Problems Experienced by Different Groups of Skilled Internet Users: Gender, Age, and Background

Jane Billestrup, Anders Bruun and Jan Stage

The paper has been published in the
International Conference on Human-Centred Software Engineering,
pp. 45–55, 2016.

The layout has been revised.

Abstract

Finding the right test persons to represent the target user group, when conducting a usability evaluation is considered essential by the HCI research community. This paper explores data from a usability evaluation with 41 participants with high IT skills, to examine if age, gender, and job function or educational background, has an impact on the amount and types of usability problems experienced by the users. All usability problems were analysed and categorised through closed coding, to group the test persons differently in relation to gender, age, and job function or educational background. The study found that the usability problems experienced across gender, age group and job function or educational background, are approximately the same. This indicates that the usual characteristics of test persons, might not be as important, and opens up for further research in regards to, if users with different skill levels, in regards to internet usage, might be more applicable.

1 Introduction

Usability evaluation is a strong tool for identifying areas of an interactive system that need improvement. In practice, one of the key challenges for usability evaluators is to find users that can participate as tests subjects. Recruitment of test subjects is challenging, and the time required for test sessions and the subsequent data analysis is usually dependent on the number of the number of test subjects. Therefore, there have been attempts to determine the minimal number of test users required for a usability evaluation (Hwang & Salvendy, 2010; Lewis, 1994; Virzi, 1992).

Other researchers have criticised these attempts to define the minimal number. One of the arguments is that different users experience different usability problems (Law & Hvannberg, 2004; Schmettow, 2012). In these discussions, there has been little evidence as to the actual differences between the usability problems experienced by different groups of users.

For specialised systems that are used by a homogeneous group of users, this issue is not particularly relevant. However, for systems that are aimed at diverse and heterogeneous groups of users, it is highly relevant.

This paper presents results from an exploratory study of the usability problems experienced by different users. The focus of this study was to what extent different test persons, who are all experienced internet users, experience different types of usability problems, across gender, age, and educational background or job function.

The system we evaluated was a government data dissemination website aimed at a very broad user population. In the following section, the related work is presented, followed by a description of the method used for data collection and analysis. Then the results are presented, and finally, the results

are discussed and concluded upon.

2 Related Work

The question about the number of test subjects needed in a usability evaluation has been discussed for many years. Virzi (1992) focused on the need exists to reduce the cost of applying good design practices, such as user testing, to the development of user interfaces. He was one of the first to experiment with the number of test subjects needed. Over a series of 3 experiments, he found that 80% of the usability problems were detected with four or five subjects, additional subjects were less and less likely to reveal new information, and the most severe usability problems were likely to be detected with the first few subjects. In the experiments, he used test subjects who were from the surrounding community or undergraduate students. There is no further description of their demography.

Lewis (1994) emphasises that a usability evaluation aims to have representative participants. He reports from an experiment with fifteen employees of a temporary help agency who all had at least three months' experience with a computer system but had no programming training or experience. Five were clerks or secretaries, and ten were business professionals. In this study, using five participants uncovered only 55% of the problems. To uncover 80% of the problems would require 10 participants. The results show that additional participants discover fewer and fewer problems. The most important result was that problem discovery rates were the same regardless of the problem severity. Again, there is no concern for the demography of the test subjects.

Caulton (2001) argues that the results obtained in these early experiments were based on the assumption that all types of users have the same probability of encountering all usability problems, and he denotes this as the homogeneity assumption. If that is violated, more subjects are needed. He argues that with heterogeneous user groups, problem detection with a given number of subjects is reduced. The more subgroups, the lower the proportion of problems expected. If ten unknown user subgroups exist, 50 randomly sampled subjects should yield 80% of the problems.

Law and Hvannberg (2004) have worked more on the influence of subgroups on problem detection through an experiment with usability tests conducted in four different European countries. They conclude that the heterogeneity of subgroups in a test will dilute the problem detection rate. Not only for severe problems but also for moderate and minor ones, the diluting effect implied a reduction. The problem detection rate for the severe problems is significantly higher than for the less severe, but the absolute value for the severe problems is not particularly high. Between nine and ten participants were required to uncover 80% of the severe problems, whereas 15 partici-

pants were required to uncover 80% of the minor problems. In addition, they found no significant correlation between problem detection rate and problem severity level. Based on their results, they reject that so-called "magic five" assumption as 11 participants were required to obtain 80% of the usability problems.

More recently, there has been another attempt to define a specific "magic" number (Hwang & Salvendy, 2010). This new attempt has been criticised for being flawed (Schmettow, 2012). A detailed analysis has been made of the use of the "magic five" assumption. None of these or the previous references in this area has explored in more detail how different heterogeneous subgroups are and how different user groups experience different usability problems.

3 Method

We have conducted an exploratory study of usability problems experienced by different user groups. This section describes how the data was collected and analysed.

3.1 Data Collection

The data was gathered through a usability evaluation of a data dissemination website (dst.dk). This site provides publicly available statistics about the population (e.g. educational level or IT skills), the economy, employment situation, etc.

Test Persons

All test persons were invited through emails distributed across the university. For this study data from 41 usability evaluations were included. The test persons consist of 12 faculty members from PhD students to professors, from different departments, 15 students in technical or non-technical educations, and 14 participants from technical and administrative staff from different departments. All participants received a gift with a value of approximately 20 USD for their participation. An overview of the participants can be seen in Table 6.1.

All test persons were placed in one of six groups in regards to gender and age. The test persons varied in age between 21 and 66 years and consisted of 19 males and 22 females. All test persons were asked to assess their own skill level in regards to Internet usage on a scale from 1 to 5, where 1 was the lowest and 5 the highest score. The average for each group is shown in the table, none of the 41 test persons assessed themselves lower than 4. Originally 43 usability evaluations were conducted, but the data from two

usability evaluations were excluded from this study, due to these test persons assessed themselves at skill level 3 in regards to Internet usage. All test persons were asked if they were familiar with, and used this website. 19 people answered that they had never used the website, 20 answered that they were familiar with the site and used it approximately once a year, and, two people answered that they use the website approximately once a month.

Usability Evaluations

All tests were conducted as think-aloud evaluations in a usability laboratory. The test monitor and test person were placed in different rooms and communicated through microphone and speakers to avoid the possibility of the test moderator's body language or other visible expressions, influencing each test person. All test persons were asked to fill out a short questionnaire after the test in regards to their participation.

Tasks

Each user solved eight tasks all varying in difficulty. Examples of this were that the first task was to find the total number of people living in Denmark while a more difficult task was to find the number hotels and restaurants with one single employee in a particular area of Denmark.

Data Handling

All usability evaluations were recorded and the collected recordings were analysed by conducting video analysis. All recordings were analysed by two evaluators. Both evaluators had extensive previous experience in analysing video data. The videos were analysed in different random order, to reduce possible bias from learning.

The following characteristics were used to determine a usability problem;

- Slowed down relative to their normal work speed,
- Inadequate understanding e.g. does not understand how a specific functionality operates or is activated,
- Frustration (expressing aggravation),
- Test moderator intervention,
- Error compared to correct approach.

The data handling resulted in a list of 147 usability problems after duplicates had been removed. To determine similarities between problems

Number of people in each category	Age	Age average	Gender	Backgrounds	Average Internet experience
6	< 27	24	M	5 Computer Science students 1 Computer Science faculty	5.0
8	< 27	22	F	5 Computer Science students 2 Humanities students 1 office trainee	4.6
8	27–44	36	M	4 Computer Science faculty 1 Social Science faculty 1 technical staff 1 administrative staff 1 engineering student	4.8
8	27–44	38	F	6 administrative staff 1 Social Science faculty 1 Information Science student	4.3
5	44<	55	M	3 Computer Science faculty 1 Medicine faculty 1 technical staff	4.8
6	44<	50	F	4 administrative staff 1 Computer Science faculty 1 Medicine faculty	4.5

Table 6.1: Demography for the 41 test persons.

from each list, the usability problems found by each evaluator were discussed. Across the analysis, the evaluators had an any-two agreement of 0.44 (SD = 0.11), which is relatively high compared to other studies (Hertzum & Jacobsen, 2003). Further information about the data collection can be found in (Bruun & Stage, 2015).

Data Analysis

We also uncovered which types of usability problems that were experienced by the different groups of participants. We did this through closed coding (Strauss & Corbin, 1994) where each problem was categorised according to the 12 types listed in Nielsen, Overgaard, Pedersen, Stage, and Stenild (2006). Two of the authors conducted this coding and did so independently of each other. It was decided in advance that the raters would code all and only use the data from the codings where the authors agreed on the category independently of each other. An interrater reliability analysis using the Fleiss Kappa statistic was performed to validate the result. This determines the level of consistency among the two raters. The result of was a moderate level of agreement (Kappa = 0.44, $p < 0.001$, 95% CI = 0.37, 0.52) (Landis & Koch, 1977). The 12 categories used for this study are described next.

Affordance relates to issues on the user's perception versus the actual properties of an object or interface.

Cognitive load regards the cognitive efforts necessary to use the system.

Consistency concerns the consistency in labels, icons, layout, wording, commands etc. on the different screens.

Ergonomics covers issues related to the physical properties of interaction.

Feedback regards the manner in which the interface relays information back to the user on an action that has been done and notifications about system events.

Information covers the understandability and amount of information presented by the interface at a given moment.

Interaction styles concern the design strategy and determine the structure of interactive resources in the interface.

Mapping is about the way in which controls and displays correlate to natural mappings and should ideally mimic physical analogies and cultural standards.

Navigation regards the way in which the users navigate from screen to screen in the interface.

Task flow relates to the order of steps in which tasks ought to be conducted.

User's mental model covers problems where the interactive model, developed by the user during system use, does not correlate with the actual model applied to the interface.

Visibility regards the ease with which users are able to perceive the available interactive resources at a given time.

The coding and analysis by two raters resolved in a list of 83 coded usability problems, out of originally 147 usability problems. This reduction happened as all usability problems where the raters did not agree on the category was removed from the study.

These categorisations were used to distinguish if test persons experienced the same type of usability problems, or if there were deviations across gender, age, job function or educational background. The results of this analysis are presented in the following section.

4 Results

In this section, we present the results from conducting this study. The results are presented from four different perspectives. First, the test persons are divided into males and females, then into the three age groups without taking the gender into perspective, then, the test persons are divided into groups both in regards to age and gender, and finally, the test persons are divided into groups in regards to education or work function. This was conducted to show if gender, age or background plays a role in regards to differences in the perceiving of usability problems. The numbers shown in the tables in the result section represent an average number of usability problems found per test person in each category. This was conducted to be able to compare groups containing different numbers of test persons, and still make the numbers comparable.

The results show that problems were found in regards to five of the twelve closed codings. Affordance, Cognitive Load, Feedback, Information, and Visibility, respectively. As problems were not found relating to Consistency, Ergonomics, Interaction Styles, Mapping, Navigation, User's Mental Model, and Task Flow, these categorisations will not be mentioned further.

Note that all results are based on the number of problems to which the two raters agreed on the categorisations, e.g. if the two raters did not agree on the code of a particular problem, this was excluded from the result. Out of the total 147 problems the raters agreed on 83.

	Gender	N	Mean	Std. deviation	Std. error mean
Affordance	M	10	1.40	0.516	0.163
	F	11	1.36	0.674	0.203
Cognitive Load	M	19	2.32	2.126	0.490
	F	22	3.77	2.159	0.460
Feedback	M	7	1.00	0.000	0.000
	F	5	1.20	0.447	0.200
Information	M	19	3.58	1.610	0.369
	F	22	4.95	2.952	0.629
Visibility	M	17	2.00	1.225	0.297
	F	19	1.58	0.769	0.176
Total	M	19	9.79	3.896	0.894
	F	22	11.05	4.904	1.045

Table 6.2: The average number of usability problems experienced when dividing the test persons by gender.

4.1 Gender

We analysed whether males and females with similar skills in regards to internet usage experienced the same amount and type of usability problems. The results are presented in Table 6.2.

An independent samples t-test revealed no significant differences in the total number of experienced between the genders ($t=-0.9$, $df=39$, $p>0.2$). We did, however find significant differences when considering the problem types related to feedback ($t=-1.2$, $df=10$, $p<0.01$) and information ($t=-1.8$, $df=39$, $p<0.01$).

4.2 Age

We also analysed if age had an impact on the experienced amount of usability problems. The results are presented in Table 6.3.

A one-way ANOVA test revealed no significant differences in number of experienced problems between the three age groups ($F=1.02$, $df=40$, $p>0.3$).

4.3 Job Function and Educational Background

Finally, we analysed if a large number of test persons with a background in computer science had an impact in regards to the amount of usability problems experienced. The results are presented in Table 6.4.

The table shows, that when dividing the test persons into job function or educational background, students which are not in computer science, ex-

	Age	N	Mean	Std. deviation
Affordance	<27	5	1.40	0.548
	27–44	9	1.56	0.726
	>44	7	1.14	0.378
	Total	21	1.38	0.590
Cognitive Load	<27	14	3.79	2.326
	27–44	16	3.81	2.257
	>44	11	2.91	1.700
	Total	41	3.56	2.134
Feedback	<27	5	1.00	0.000
	27–44	6	1.17	0.408
	>44	1	1.00	
	Total	12	1.08	0.289
Information	<27	14	5.29	2.555
	27–44	16	4.19	2.562
	>44	11	3.27	2.005
	Total	41	4.32	2.494
Visibility	<27	13	1.62	0.961
	27–44	13	1.69	0.855
	>44	10	2.10	1.287
	Total	36	1.78	1.017
Total	<27	14	11.43	4.767
	27–44	16	10.69	4.771
	>44	11	8.91	3.419
	Total	41	10.46	4.456

Table 6.3: Usability problems experienced by different age groups.

	Background	N	Mean	Std. deviation
Affordance	Other students	2	1.00	0.000
	CS students	3	1.67	0.577
	TAP	10	1.50	0.707
	CS faculty	3	1.00	0.000
	Other faculty	3	1.33	0.577
	Total	21	1.38	0.590
Cognitive Load	Other students	4	5.75	0.500
	CS students	11	3.27	2.195
	TAP	15	3.47	1.846
	CS faculty	7	4.00	2.887
	Other faculty	4	1.75	0.500
	Total	41	3.56	2.134
Feedback	Other students	0		
	CS students	3	1.00	0.000
	TAP	3	1.00	0.000
	CS faculty	4	1.00	0.000
	Other faculty	2	1.50	0.707
	Total	12	1.08	0.289
Information	Other students	4	5.00	3.559
	CS students	11	4.55	2.067
	TAP	15	4.87	3.021
	CS faculty	7	3.14	1.069
	Other faculty	4	3.00	1.826
	Total	41	4.32	2.494
Visibility	Other students	3	1.33	0.577
	CS students	10	1.60	1.075
	TAP	14	1.79	0.802
	CS faculty	6	2.33	1.506
	Other faculty	3	1.67	1.155
	Total	36	1.78	1.017
Total	Other students	4	12.25	4.031
	CS students	11	10.00	4.123
	TAP	15	11.20	5.003
	CS faculty	7	10.14	4.140
	Other faculty	4	7.75	4.787
	Total	41	10.46	4.456

Table 6.4: The average amount of usability problems experienced when dividing the test persons in regards to job function or educational background.

perience more problems related to cognitive load and information. A one-way ANOVA test revealed no significant differences in the total number of problems experienced across job function or educational background ($F=0.6$, $df=40$, $p>0.6$).

5 Discussion

This study has focused on comparing the number of usability problems found when grouping the test persons in regards to gender, age, and job function or educational background. This was conducted as all test persons assessed themselves as experienced internet users, as each rated themselves as either 4 or 5 on a scale from 1 to 5, where five was the highest score. This way, it could be explored if test persons of a high degree of internet skills experienced different types of usability problems, or if they could be considered a homogeneous group, where neither age, gender, and job function or educational background made a difference in regards to the average amount of usability problems.

5.1 Comparison with Related Work

Related work has shown that the amount of needed test persons varies (Lewis, 1994; Virzi, 1992). As demographical data was not included in these studies it is not possible for us to draw any conclusions in relation to the results from this study, though it raises the question of, if the test persons chosen by Virzi (1992) were more homogeneous than the test persons chosen by Lewis (1994) in regards to the skills of Internet usage or IT in general.

This study has found indications that a user group can be homogeneous though a variety of age and background. Our results indicated that the test persons from this study experience around the same amount of usability problems in regard to each categorisation (Affordance, Cognitive Load, Feedback, Information, Visibility), across gender, age, and background. This corresponds to Carlton's' conclusions about homogeneous user groups experiencing the same usability problems (Caulton, 2001).

This study shows no greater difference in regards to the types of usability problems experienced by the test persons. This does not correspond with the findings of Law and Hvannberg who concluded that the heterogeneity of subgroups in a test would dilute the problem detection rate (Law & Hvannberg, 2004).

5.2 Implications for Usability Practitioners

Though further research is needed, this study indicates that recruiting test persons across gender, and age might not be necessary, as these findings show that users with approximately the same level of skills in regards to Internet usage, experience the same amount of usability problems. If, the indication that skill level is key when recruiting test persons for usability evaluations, this means that the most important is to recruit test persons of all skill levels of the target user group for the website or application, and, that variety in age or gender is not important when recruiting test persons. The implications might especially be of interest, when developing websites or applications for large heterogeneous user groups, e.g. public websites or self-service applications, as these types of sites are targeted for all citizens in a country. This will make it challenging to represent all types of users when conducting usability evaluations, as a lot of test persons would need to be recruited, and it would be costly to conduct this amount of usability evaluations. On the contrary, if test persons only need to be recruited in regards to their skill level of Internet usage and IT in general, this would reduce the cost considerably.

6 Conclusion

This paper presents a study of to what extent different test persons, who are all experienced internet users, experience different types of usability problems. This has been presented across age, gender, and educational background or job function. The results are interesting as it is indicated that the usability problems experienced by users with a high level of internet experience do not vary significantly, across gender, age or background. This means that finding test persons might not have to be balanced in regards to neither gender or age, but that is more important to find test persons on all levels of internet experience in the target user group. Our results also indicate that people with an education in Computer Science do not experience significantly fewer usability problems, than other experienced internet users.

6.1 Limitations

We do recognise that further studies need to be conducted to be able to draw conclusions across user groups at different levels of Internet experience and that these results do not provide enough evidence to definitively rejecting the previously mentioned criticism of the "homogeneity assumption" by Law and Hvannberg (2004). This means that further research should be conducted with more homogeneous user groups with different levels of internet skills, and not just one group of experienced users. As it needs to be investigated

further if these results also are valid for other user groups with lower skill levels in regards to Internet usage.

We also recognise the limitations of our test persons having a higher educational background and self-reported high expertise in internet usage. Also the fact that a lot of the found usability problems were discarded at the coding phase and therefore not included in the data analysis.

References

Bruun, A., & Stage, J. (2015). An empirical study of the effects of three think-aloud protocols on identification of usability problems. In *Human-Computer Interaction* (pp. 159–176).

Caulton, D. A. (2001). Relaxing the homogeneity assumption in usability testing. *Behaviour & Information Technology*, *20*(1), 1–7.

Hertzum, M., & Jacobsen, N. E. (2003). The evaluator effect: A chilling fact about usability evaluation methods. *International journal of human-computer interaction*, *15*(1), 183–204.

Hwang, W., & Salvendy, G. (2010). Number of people required for usability evaluation: the 10±2 rule. *Communications of the ACM*, *53*(5), 130–133.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *biometrics*, 159–174.

Law, E. L.-C., & Hvannberg, E. T. (2004). Analysis of combinatorial user effect in international usability tests. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 9–16).

Lewis, J. R. (1994). Sample sizes for usability studies: Additional considerations. *Human factors*, *36*(2), 368–378.

Nielsen, C. M., Overgaard, M., Pedersen, M. B., Stage, J., & Stenild, S. (2006). It's worth the hassle!: The added value of evaluating the usability of mobile systems in the field. In *Proceedings of the 4th Nordic conference on Human-Computer Interaction* (pp. 272–280).

Schmettow, M. (2012). Sample size in usability studies. *Communications of the ACM*, *55*(4), 64–70.

Strauss, A., & Corbin, J. (1994). Grounded theory methodology. *Handbook of qualitative research*, *17*, 273–85.

Virzi, R. A. (1992). Refining the test phase of usability evaluation: How many subjects is enough? *Human factors*, *34*(4), 457–468.

ISSN (online): 2446-1628
ISBN (online): 978-87-7210-135-4

AALBORG UNIVERSITY PRESS